US008961119B2

(12) United States Patent
McKeever et al.

(10) Patent No.: US 8,961,119 B2
(45) Date of Patent: Feb. 24, 2015

(54) **AIRFOIL SHAPE FOR A COMPRESSOR**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 410 days.

(21) Appl. No.: **13/526,941**

(22) Filed: **Jun. 19, 2012**

(65) **Prior Publication Data**

US 2013/0336780 A1 Dec. 19, 2013

(51) **Int. Cl.**
F01D 9/02 (2006.01)

(52) **U.S. Cl.**
USPC .... **415/191**; 416/223 R; 416/223 A; 416/DIG. 2

(58) **Field of Classification Search**
USPC .... 416/191, 223 R, 223 A, 242, 243, DIG. 2; 415/191
See application file for complete search history.

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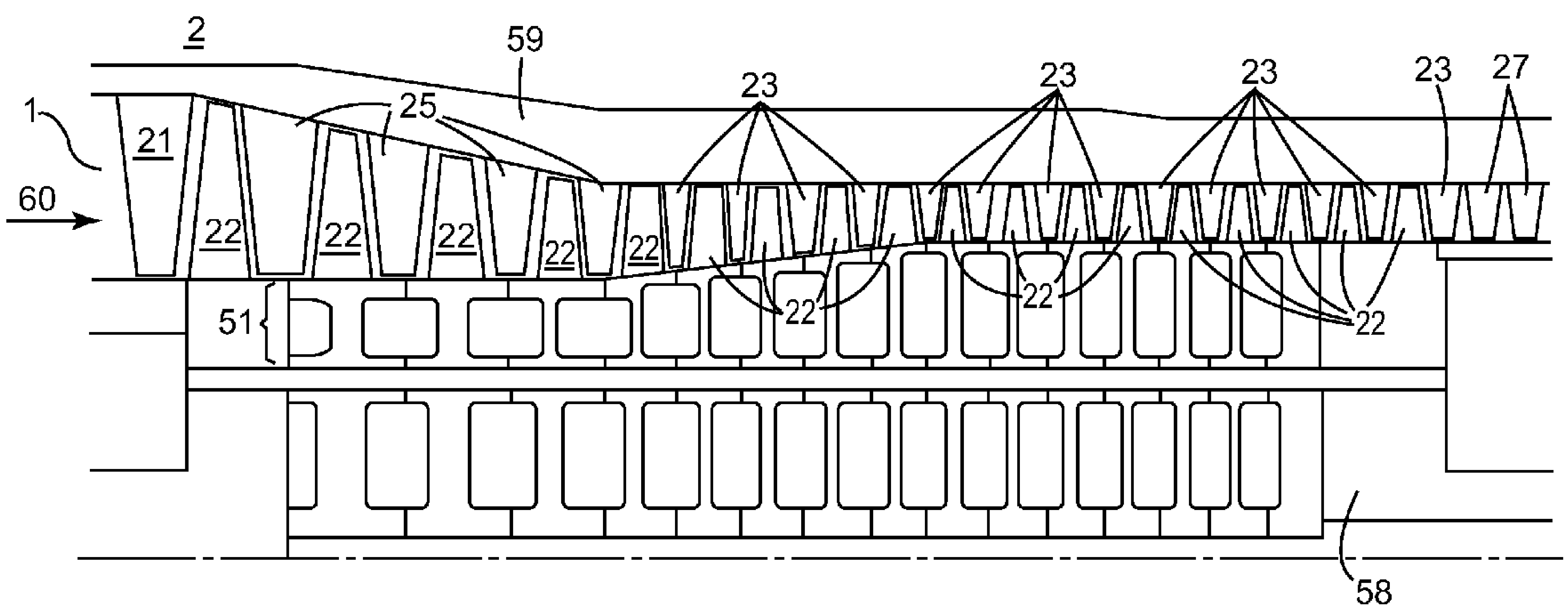
(57) **ABSTRACT**

An article of manufacture having a nominal airfoil profile substantially in accordance with Cartesian coordinate values of X, Y and Z set forth in scalable Table 1 wherein the Cartesian coordinate values of X, Y and Z are non-dimensional values convertible to dimensional distances by multiplying the Cartesian coordinate values of X, Y and Z by a number, and wherein X and Y are coordinates which, when connected by continuing arcs, define airfoil profile sections at each Z height, the airfoil profile sections at each Z height being joined smoothly with one another to form a complete airfoil shape.

18 Claims, 2 Drawing Sheets



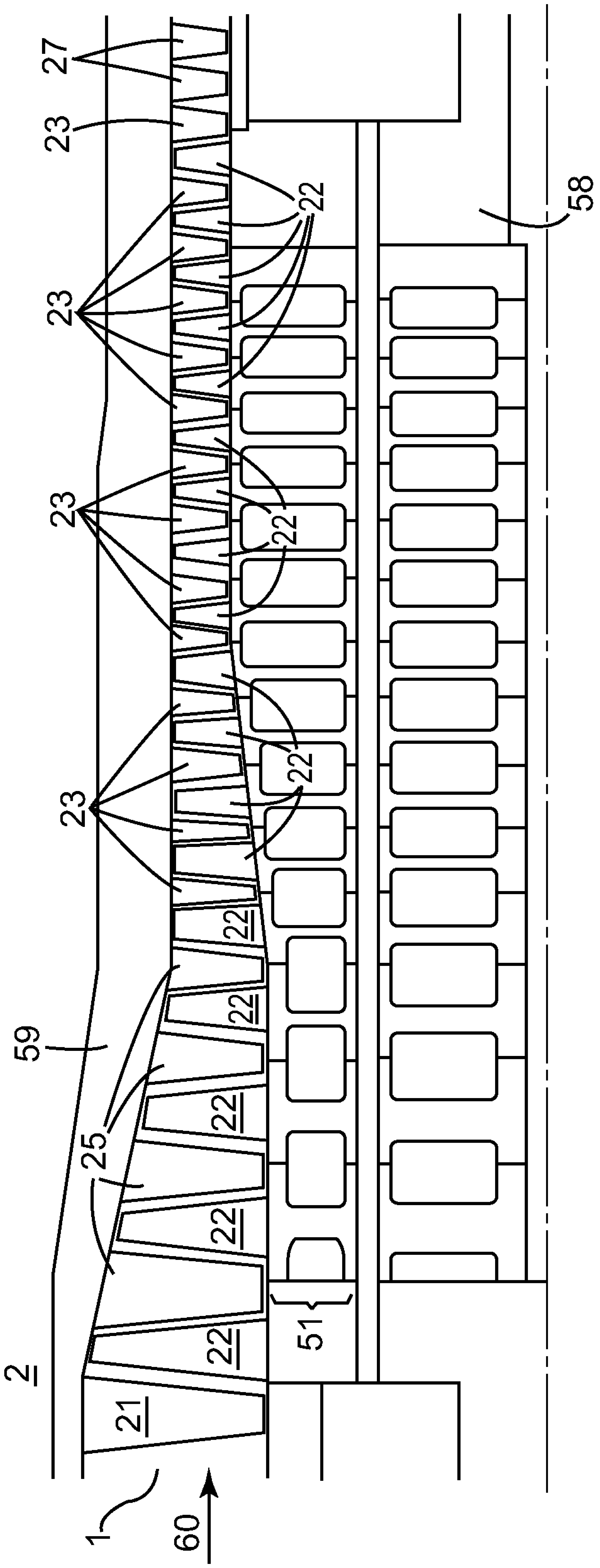


FIG. 1

FIG. 2

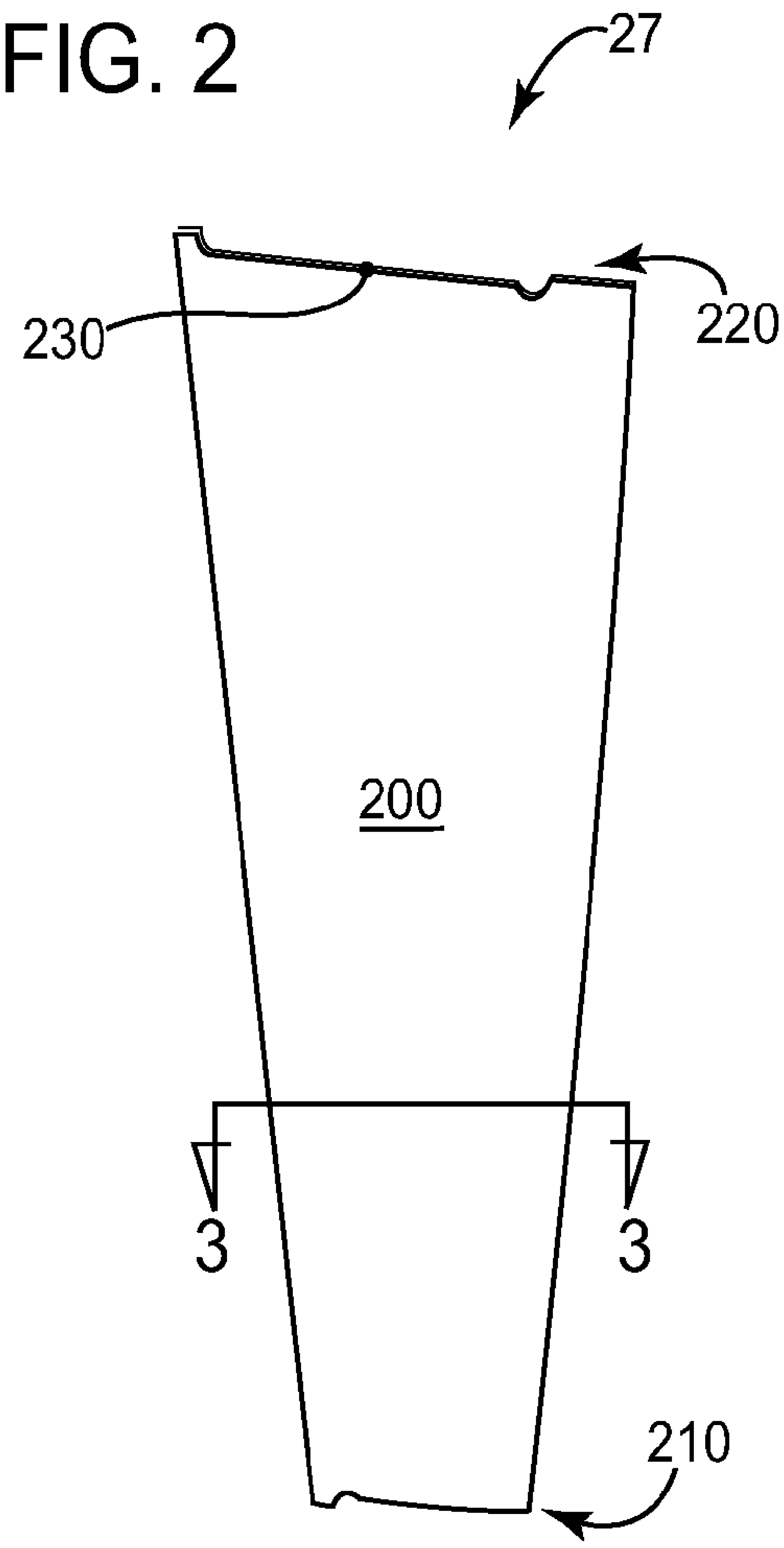
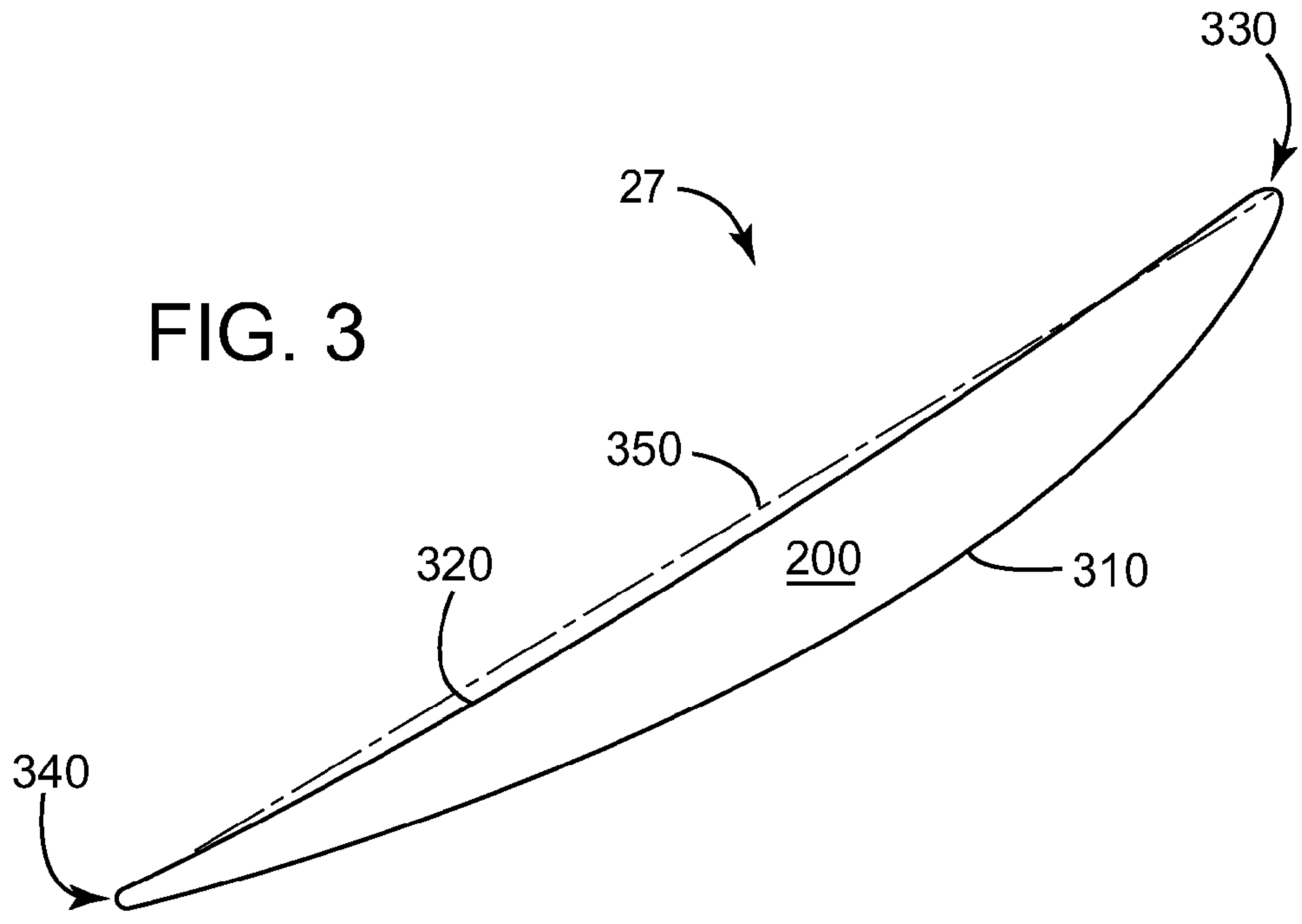


FIG. 3



AIRFOIL SHAPE FOR A COMPRESSOR

RELATED APPLICATIONS

The present application is related to Ser. Nos. 13/526,832, 13/526,863, 13/526,893, 13/526,920 filed concurrently herewith, which are each fully incorporated by reference herein and made a part hereof.

BACKGROUND OF THE INVENTION

The present invention relates generally to an airfoil for use in turbomachinery, and more particularly relates to an airfoil profile or airfoil shape for use in a compressor.

In turbomachines, many system requirements should be met at each stage of the turbomachine's flow path to meet design goals. These design goals include, but are not limited to, overall improved efficiency, reduction of vibratory response and improved airfoil loading capability. For example, a compressor airfoil profile should achieve thermal and mechanical operating requirements for a particular stage in the compressor. Moreover, component lifetime, reliability and cost targets also should be met.

BRIEF DESCRIPTION OF THE INVENTION

According to one aspect of the present invention an article of manufacture is provided having a nominal airfoil profile substantially in accordance with Cartesian coordinate values of X, Y and Z set forth in scalable Table 1 wherein the Cartesian coordinate values of X, Y and Z are non-dimensional values convertible to dimensional distances by multiplying the Cartesian coordinate values of X, Y and Z by a number, and wherein X and Y are coordinates which, when connected by continuing arcs, define airfoil profile sections at each Z height, the airfoil profile sections at each Z height being joined smoothly with one another to form a complete airfoil shape.

According to another aspect of the present invention an article of manufacture is provided having a suction-side nominal airfoil profile substantially in accordance with suction-side Cartesian coordinate values of X, Y and Z set forth in scalable Table 1 wherein the Cartesian coordinate values of X, Y and Z are non-dimensional values convertible to dimensional distances by multiplying the Cartesian coordinate values of X, Y and Z by a number, and wherein X and Y are coordinates which, when connected by continuing arcs, define airfoil profile sections at each Z height, the airfoil profile sections at each Z height being joined smoothly with one another to form a complete suction-side airfoil shape, the X, Y and Z coordinate values being scalable as a function of the number to provide at least one of a non-scaled, scaled-up and scaled-down airfoil profile.

According to yet another aspect of the present invention a compressor is provided having a plurality of exit guide vanes, each of the exit guide vanes including an airfoil having a suction-side airfoil shape, the airfoil having a nominal profile substantially in accordance with suction-side Cartesian coordinate values of X, Y and Z set forth in scalable Table 1 wherein the Cartesian coordinate values of X, Y and Z are non-dimensional values convertible to dimensional distances by multiplying the Cartesian coordinate values of X, Y and Z by a number, and wherein X and Y are coordinates which, when connected by continuing arcs, define airfoil profile sections at each Z height, the airfoil profile sections at each Z height being joined smoothly with one another to form a complete suction-side airfoil shape.

These and other features and improvements of the present invention should become apparent to one of ordinary skill in the art upon review of the following detailed description when taken in conjunction with the several drawings and the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a schematic representation of a compressor flow path through multiple stages and illustrates exemplary compressor stages according to an aspect of the invention;

FIG. **2** is a perspective view of an exit guide vane, according to an aspect of the invention; and

FIG. **3** is a cross-sectional view of the exit guide vane airfoil taken generally about on line **3-3** in FIG. **2**, according to an aspect of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

One or more specific aspects/embodiments of the present invention will be described below. In an effort to provide a concise description of these aspects/embodiments, all features of an actual implementation may not be described in the specification. It should be appreciated that in the development of any such actual implementation, as in an engineering or design project, numerous implementation-specific decisions must be made to achieve the developers' specific goals, such as compliance with machine-related, system-related and business-related constraints, which may vary from one implementation to another. Moreover, it should be appreciated that such a development effort might be complex and time consuming, but would nevertheless be a routine undertaking of design, fabrication, and manufacture for those of ordinary skill having the benefit of this disclosure.

When introducing elements of various embodiments of the present invention, the articles "a," "an," "the," and "said" are intended to mean that there are one or more of the elements. The terms "comprising," "including," and "having" are intended to be inclusive and mean that there may be additional elements other than the listed elements. Any examples of operating parameters and/or environmental conditions are not exclusive of other parameters/conditions of the disclosed embodiments. Additionally, it should be understood that references to "one embodiment", "one aspect" or "an embodiment" or "an aspect" of the present invention are not intended to be interpreted as excluding the existence of additional embodiments or aspects that also incorporate the recited features. Turbomachinery is defined as one or more machines that transfer energy between a rotor and a fluid or vice-versa, including but not limited to gas turbines, steam turbines and compressors.

Referring now to the drawings. FIG. **1** illustrates an axial compressor flow path **1** of a compressor **2** that includes a plurality of compressor stages. The compressor **2** may be used in conjunction with, or as part of, a gas turbine. As one non-limiting example only, the compressor flow path **1** may comprise about eighteen rotor/stator stages. However, the exact number of rotor and stator stages is a choice of engineering design, and may be more or less than the illustrated eighteen stages. It is to be understood that any number of rotor and stator stages can be provided in the compressor, as embodied by the invention. The eighteen stages are merely exemplary of one turbine/compressor design, and are not intended to limit the invention in any manner.

The compressor rotor blades **22** impart kinetic energy to the airflow and therefore bring about a desired pressure rise. Directly following the rotor blades **22** is a stage of stator compressor vanes **23**. However, in some designs the stator vanes may precede the rotor blades. Both the rotor blades and stator vanes turn the airflow, slow the airflow velocity (in the respective airfoil frame of reference and yield a rise in the static pressure of the airflow. Typically, multiple rows of rotor/stator stages are arranged in axial flow compressors to achieve a desired discharge to inlet pressure ratio. Each rotor blade and stator vane includes an airfoil, and these airfoils can be secured to rotor wheels or a stator case by an appropriate attachment configuration, often known as a "root," "base" or "dovetail" (not shown). In addition, compressors may also include inlet guide vanes (IGVs) **21**, variable stator vanes (VSVs) **25** and exit (or exhaust) guide vanes (EGVs) **27**. In some applications, the VSVs **25** may be located towards the front or inlet) of the compressor. All of these blades and vanes have airfoils that act on the medium (e.g., air) passing through the compressor flow path **1**.

Exemplary stages of the compressor **2** are illustrated in FIG. **1**. One stage of the compressor **2** comprises a plurality of circumferentially spaced rotor blades **22** mounted on a rotor wheel **51** and a plurality of circumferentially spaced stator vanes **23** attached to a static compressor case **59**. Each of the rotor wheels **51** may be attached to an aft drive shaft **58**, which may be connected to the turbine section of the engine. The rotor blades **22** and stator vanes **23** lie in the flow path **1** of the compressor **2**. The direction of airflow through the compressor flow path **1**, as embodied by the invention, is indicated by the arrow **60** (FIG. **1**), and flows generally from left to right in the illustration. The rotor blades and stator vanes herein of the compressor **2** are merely exemplary of the stages of the compressor **2** within the scope of the invention. In addition, each inlet guide vane **21**, rotor blade **22**, stator vane **23**, variable stator vane **25** and exit guide vane **27** may be considered an article of manufacture. Further, the article of manufacture may comprise an exit guide vane configured for use with a compressor.

An exit guide vane **27**, illustrated in FIG. **2**, is provided with an airfoil **200**. Each of the exit guide vanes **27** has an airfoil profile at any cross-section from the airfoil root **220** to the airfoil tip **210**. Referring to FIG. **3**, it will be appreciated that each exit guide vane **27** has an airfoil **200** as illustrated. The airfoil **200** has a suction side (or surface) **310** and a pressure side (or surface) **320**. The suction side **310** is located on the opposing side of the airfoil from the pressure side **320**. Thus, each of the exit guide vanes **27** has an airfoil profile at any cross-section in the shape of the airfoil **200**. The airfoil **200** also includes a leading edge **330** and a trailing edge **340**, and a chord length **350** extends therebetween. The root of the airfoil corresponds to the lowest non-dimensional Z value of scalable Table 1. The tip of the airfoil corresponds to the highest non-dimensional Z value of scalable Table 1. An airfoil may extend beyond the compressor flowpath and may be tipped to achieve the desired endwall clearances. As non limiting examples only, the height of the airfoil **200** may be from about 1 inch to about 15 inches or more, about 2 inches to about 10 inches, or about 2 inches to about 5 inches. However, any specific airfoil height may be used as desired in the specific application.

The compressor flow path **1** requires airfoils that meet system requirements of aerodynamic and mechanical blade/vane loading and efficiency. For example, it is desirable that the airfoils are designed to reduce the vibratory response or vibratory stress response of the respective blades and/or vanes. Materials such as high strength alloys, non-corrosive alloys and/or stainless steels may be used in the blades and/or vanes. To define the airfoil shape of each blade airfoil and/or vane airfoil, there is a unique set or loci of points in space that meet the stage requirements and can be manufactured. These unique loci of points meet the requirements for stage efficiency and are arrived at by iteration between aerodynamic and mechanical loadings enabling the turbine and compressor to run in an efficient, safe, reliable and smooth manner. These points are unique and specific to the system. The locus that defines the airfoil profile includes a set of points with X, Y and Z coordinates relative to a reference origin coordinate system. The three-dimensional Cartesian coordinate system of X, Y and Z values given in scalable Table 1 below defines the profile of the exit guide vane airfoil at various locations along its length. Scalable Table 1 lists data for a non-coated airfoil. The envelope/tolerance for the coordinates is about +/−5% of the chord length **350** in a direction normal to any airfoil surface location, or about +/−0.25 inches in a direction normal to any airfoil surface location. However, tolerances of about +/−0.15 inches to about +/−0.25 inches, or about +/−3% to about +/−5% in a direction normal to an airfoil surface location may also be used, as desired in the specific application.

The point data origin **230** may be the mid-point of the suction or pressure side of the base of the airfoil, the leading edge or trailing edge of the base of the airfoil, or any other suitable location as desired. The coordinate values for the X, Y and Z coordinates are set forth in non-dimensionalized units in scalable Table 1 although other units of dimensions may be used when the values are appropriately converted. As one example only, the Cartesian coordinate values of X, Y and Z may be convertible to dimensional distances by multiplying the X, Y and Z values by a multiplying by a constant number (e.g., 100). The number, used to convert the non-dimensional values to dimensional distances, may be a fraction (e.g., ½, ¼, etc.), decimal fraction (e.g., 0.5, 1.5, 10.25, etc.), integer (e.g., 1, 2, 10, 100, etc.) or a mixed number (e.g., 1½, 10¼, etc.). The dimensional distances may be any suitable format (e.g., inches, feet, millimeters, centimeters, meters, etc.). As one non-limiting example only, the Cartesian coordinate system has orthogonally-related X, Y and Z axes and the X axis may lie generally parallel to the compressor rotor centerline, i.e., the rotary axis and a positive X coordinate value is axial toward the aft, i.e., exhaust end of the turbine. The positive Y coordinate value extends tangentially in the direction of rotation of the rotor and the positive Z coordinate value is radially outwardly toward the rotor blade tip or stator vane base. All the values in scalable Table 1 are given at room temperature and are unfilleted.

By defining X and Y coordinate values at selected locations in a Z direction (or height) normal to the X, Y plane, the profile section or airfoil shape of the airfoil, at each Z height along the length of the airfoil can be ascertained. By connecting the X and Y values with smooth continuing arcs, each profile section at each Z height is fixed. The airfoil profiles of the various surface locations between each Z height are determined by smoothly connecting the adjacent profile sections to one another to form the airfoil profile.

The Table 1 values are generated and shown from zero to for or more decimal places for determining the profile of the airfoil. As the airfoil heats up the associated stress and temperature will cause a change in the X, Y and Z values. Accordingly, the values for the profile given in Table 1 represent ambient, non-operating or non-hot conditions (e.g., room temperature) and are for an uncoated airfoil.

There are typical manufacturing tolerances as well as optional coatings which must be accounted for in the actual profile of the airfoil. Each section is joined smoothly with the other sections to form the complete airfoil shape. It will therefore be appreciated that +/− typical manufacturing tolerances, i.e., +/− values, including any coating thicknesses, are additive to the X and Y values given in Table 1 below. Accordingly, a distance of about +/−5% of chord length and/or +/−0.25 inches in a direction normal to a surface location along the airfoil profile defines an airfoil profile envelope for this particular airfoil design and compressor, i.e., a range of variation between measured points on the actual airfoil surface at nominal cold or room temperature and the ideal position of those points as given in the Table below at the same temperature. Additionally, a distance of about +/−5% of a chord length in a direction normal to an airfoil surface location along the airfoil profile also may define an airfoil profile envelope for this particular airfoil design. The data is scalable and the geometry pertains to all aerodynamic scales, at, above and/or below about 3,600 RPM. The exit guide vane airfoil design is robust to this range of variation without impairment of mechanical and aerodynamic functions.

The coordinate values given in scalable TABLE 1 below provide the nominal profile for an exemplary stage compressor exit guide vane.

TABLE 1

SUCTION SIDE			PRESSURE SIDE		
X	Y	Z	X	Y	Z
−1.1136	0.4802	−0.2054	1.5529	−0.3359	−0.2054
−1.1172	0.4770	−0.2054	1.5527	−0.3353	−0.2054
−1.1203	0.4714	−0.2054	1.5524	−0.3342	−0.2054
−1.1218	0.4634	−0.2054	1.5516	−0.3321	−0.2054
−1.1218	0.4538	−0.2054	1.5492	−0.3281	−0.2054
−1.1202	0.4411	−0.2054	1.5436	−0.3236	−0.2054
−1.1169	0.4248	−0.2054	1.5311	−0.3214	−0.2054
−1.1112	0.4048	−0.2054	1.5138	−0.3230	−0.2054
−1.1030	0.3811	−0.2054	1.4909	−0.3253	−0.2054
−1.0920	0.3533	−0.2054	1.4622	−0.3278	−0.2054
−1.0782	0.3213	−0.2054	1.4248	−0.3307	−0.2054
−1.0602	0.2841	−0.2054	1.3818	−0.3335	−0.2054
−1.0379	0.2419	−0.2054	1.3356	−0.3358	−0.2054
−1.0114	0.1951	−0.2054	1.2839	−0.3373	−0.2054
−0.9796	0.1445	−0.2054	1.2263	−0.3382	−0.2054
−0.9412	0.0909	−0.2054	1.1630	−0.3382	−0.2054
−0.8970	0.0337	−0.2054	1.0968	−0.3372	−0.2054
−0.8479	−0.0235	−0.2054	1.0277	−0.3351	−0.2054
−0.7928	−0.0805	−0.2054	0.9560	−0.3315	−0.2054
−0.7324	−0.1367	−0.2054	0.8814	−0.3263	−0.2054
−0.6667	−0.1912	−0.2054	0.8042	−0.3195	−0.2054
−0.5958	−0.2434	−0.2054	0.7242	−0.3107	−0.2054
−0.5193	−0.2931	−0.2054	0.6417	−0.2998	−0.2054
−0.4369	−0.3398	−0.2054	0.5564	−0.2864	−0.2054
−0.3515	−0.3820	−0.2054	0.4714	−0.2708	−0.2054
−0.2640	−0.4187	−0.2054	0.3869	−0.2531	−0.2054
−0.1750	−0.4503	−0.2054	0.3030	−0.2334	−0.2054
−0.0844	−0.4766	−0.2054	0.2197	−0.2116	−0.2054
0.0076	−0.4981	−0.2054	0.1369	−0.1876	−0.2054
0.1012	−0.5144	−0.2054	0.0546	−0.1619	−0.2054
0.1955	−0.5259	−0.2054	−0.0272	−0.1343	−0.2054
0.2898	−0.5328	−0.2054	−0.1083	−0.1047	−0.2054
0.3840	−0.5355	−0.2054	−0.1883	−0.0730	−0.2054
0.4780	−0.5343	−0.2054	−0.2672	−0.0393	−0.2054
0.5718	−0.5293	−0.2054	−0.3447	−0.0032	−0.2054
0.6625	−0.5214	−0.2054	−0.4185	0.0339	−0.2054
0.7499	−0.5111	−0.2054	−0.4886	0.0718	−0.2054
0.8342	−0.4989	−0.2054	−0.5549	0.1104	−0.2054
0.9152	−0.4853	−0.2054	−0.6180	0.1491	−0.2054
0.9930	−0.4709	−0.2054	−0.6776	0.1880	−0.2054
1.0673	−0.4560	−0.2054	−0.7343	0.2267	−0.2054
1.1385	−0.4409	−0.2054	−0.7879	0.2647	−0.2054
1.2064	−0.4260	−0.2054	−0.8366	0.2999	−0.2054
1.2682	−0.4121	−0.2054	−0.8803	0.3326	−0.2054
1.3236	−0.3996	−0.2054	−0.9191	0.3621	−0.2054
1.3730	−0.3888	−0.2054	−0.9534	0.3881	−0.2054
1.4194	−0.3790	−0.2054	−0.9832	0.4104	−0.2054
1.4598	−0.3710	−0.2054	−1.0087	0.4292	−0.2054
1.4908	−0.3649	−0.2054	−1.0305	0.4450	−0.2054
1.5156	−0.3603	−0.2054	−1.0492	0.4579	−0.2054

TABLE 1-continued

SUCTION SIDE			PRESSURE SIDE		
X	Y	Z	X	Y	Z
1.5342	−0.3567	−0.2054	−1.0651	0.4676	−0.2054
1.5472	−0.3516	−0.2054	−1.0783	0.4748	−0.2054
1.5518	−0.3453	−0.2054	−1.0886	0.4794	−0.2054
1.5530	−0.3403	−0.2054	−1.0969	0.4820	−0.2054
1.5530	−0.3378	−0.2054	−1.1039	0.4828	−0.2054
1.5529	−0.3366	−0.2054	−1.1097	0.4821	−0.2054
−1.1020	0.5021	0.0000	1.5574	−0.2523	0.0000
−1.1054	0.4987	0.0000	1.5574	−0.2518	0.0000
−1.1082	0.4931	0.0000	1.5572	−0.2506	0.0000
−1.1099	0.4853	0.0000	1.5565	−0.2485	0.0000
−1.1099	0.4758	0.0000	1.5543	−0.2444	0.0000
−1.1081	0.4634	0.0000	1.5492	−0.2396	0.0000
−1.1045	0.4475	0.0000	1.5369	−0.2371	0.0000
−1.0985	0.4279	0.0000	1.5199	−0.2387	0.0000
−1.0895	0.4048	0.0000	1.4974	−0.2407	0.0000
−1.0777	0.3778	0.0000	1.4691	−0.2433	0.0000
−1.0627	0.3470	0.0000	1.4324	−0.2461	0.0000
−1.0430	0.3115	0.0000	1.3898	−0.2487	0.0000
−1.0189	0.2712	0.0000	1.3446	−0.2506	0.0000
−0.9901	0.2264	0.0000	1.2935	−0.2519	0.0000
−0.9554	0.1786	0.0000	1.2369	−0.2522	0.0000
−0.9142	0.1281	0.0000	1.1746	−0.2519	0.0000
−0.8672	0.0747	0.0000	1.1094	−0.2505	0.0000
−0.8154	0.0214	0.0000	1.0414	−0.2478	0.0000
−0.7582	−0.0311	0.0000	0.9708	−0.2440	0.0000
−0.6959	−0.0831	0.0000	0.8975	−0.2385	0.0000
−0.6289	−0.1334	0.0000	0.8215	−0.2315	0.0000
−0.5570	−0.1817	0.0000	0.7429	−0.2227	0.0000
−0.4799	−0.2276	0.0000	0.6616	−0.2119	0.0000
−0.3975	−0.2709	0.0000	0.5777	−0.1988	0.0000
−0.3124	−0.3096	0.0000	0.4941	−0.1839	0.0000
−0.2259	−0.3434	0.0000	0.4107	−0.1670	0.0000
−0.1378	−0.3723	0.0000	0.3279	−0.1483	0.0000
−0.0485	−0.3962	0.0000	0.2456	−0.1278	0.0000
0.0420	−0.4152	0.0000	0.1638	−0.1054	0.0000
0.1337	−0.4294	0.0000	0.0824	−0.0817	0.0000
0.2266	−0.4392	0.0000	0.0014	−0.0562	0.0000
0.3194	−0.4447	0.0000	−0.0791	−0.0291	0.0000
0.4120	−0.4462	0.0000	−0.1590	−0.0002	0.0000
0.5044	−0.4442	0.0000	−0.2381	0.0307	0.0000
0.5964	−0.4389	0.0000	−0.3163	0.0637	0.0000
0.6854	−0.4309	0.0000	−0.3909	0.0976	0.0000
0.7708	−0.4209	0.0000	−0.4620	0.1324	0.0000
0.8533	−0.4093	0.0000	−0.5297	0.1676	0.0000
0.9325	−0.3964	0.0000	−0.5941	0.2032	0.0000
1.0087	−0.3827	0.0000	−0.6553	0.2390	0.0000
1.0815	−0.3687	0.0000	−0.7134	0.2745	0.0000
1.1513	−0.3544	0.0000	−0.7684	0.3093	0.0000
1.2180	−0.3403	0.0000	−0.8184	0.3417	0.0000
1.2786	−0.3271	0.0000	−0.8633	0.3715	0.0000
1.3329	−0.3150	0.0000	−0.9032	0.3985	0.0000
1.3814	−0.3046	0.0000	−0.9385	0.4222	0.0000
1.4268	−0.2952	0.0000	−0.9691	0.4426	0.0000
1.4664	−0.2874	0.0000	−0.9953	0.4598	0.0000
1.4967	−0.2816	0.0000	−1.0177	0.4741	0.0000
1.5211	−0.2768	0.0000	−1.0369	0.4856	0.0000
1.5394	−0.2733	0.0000	−1.0533	0.4941	0.0000
1.5520	−0.2679	0.0000	−1.0667	0.5002	0.0000
1.5563	−0.2616	0.0000	−1.0774	0.5040	0.0000
1.5574	−0.2567	0.0000	−1.0857	0.5057	0.0000
1.5575	−0.2542	0.0000	−1.0927	0.5057	0.0000
1.5574	−0.2529	0.0000	−1.0983	0.5043	0.0000
−1.0900	0.5280	0.2528	1.5644	−0.1493	0.2528
−1.0930	0.5245	0.2528	1.5643	−0.1488	0.2528
−1.0955	0.5189	0.2528	1.5642	−0.1477	0.2528
−1.0969	0.5112	0.2528	1.5635	−0.1455	0.2528
−1.0965	0.5020	0.2528	1.5614	−0.1415	0.2528
−1.0942	0.4899	0.2528	1.5564	−0.1367	0.2528
−1.0899	0.4746	0.2528	1.5443	−0.1341	0.2528
−1.0828	0.4559	0.2528	1.5276	−0.1357	0.2528
−1.0725	0.4340	0.2528	1.5053	−0.1376	0.2528
−1.0594	0.4085	0.2528	1.4774	−0.1399	0.2528
−1.0427	0.3794	0.2528	1.4412	−0.1426	0.2528
−1.0212	0.3460	0.2528	1.3992	−0.1449	0.2528
−0.9948	0.3086	0.2528	1.3546	−0.1465	0.2528
−0.9635	0.2672	0.2528	1.3043	−0.1474	0.2528

TABLE 1-continued

SUCTION SIDE			PRESSURE SIDE		
X	Y	Z	X	Y	Z
−0.9263	0.2230	0.2528	1.2486	−0.1473	0.2528
−0.8828	0.1765	0.2528	1.1870	−0.1463	0.2528
−0.8333	0.1276	0.2528	1.1228	−0.1442	0.2528
−0.7794	0.0790	0.2528	1.0559	−0.1409	0.2528
−0.7205	0.0311	0.2528	0.9862	−0.1362	0.2528
−0.6570	−0.0160	0.2528	0.9141	−0.1303	0.2528
−0.5890	−0.0615	0.2528	0.8392	−0.1228	0.2528
−0.5167	−0.1050	0.2528	0.7616	−0.1138	0.2528
−0.4398	−0.1463	0.2528	0.6815	−0.1031	0.2528
−0.3582	−0.1848	0.2528	0.5987	−0.0904	0.2528
−0.2746	−0.2191	0.2528	0.5162	−0.0762	0.2528
−0.1888	−0.2491	0.2528	0.4339	−0.0604	0.2528
−0.1011	−0.2748	0.2528	0.3520	−0.0432	0.2528
−0.0128	−0.2957	0.2528	0.2704	−0.0244	0.2528
0.0761	−0.3120	0.2528	0.1892	−0.0043	0.2528
0.1656	−0.3241	0.2528	0.1084	0.0172	0.2528
0.2558	−0.3322	0.2528	0.0279	0.0400	0.2528
0.3464	−0.3365	0.2528	−0.0522	0.0643	0.2528
0.4375	−0.3373	0.2528	−0.1319	0.0901	0.2528
0.5286	−0.3349	0.2528	−0.2111	0.1175	0.2528
0.6194	−0.3296	0.2528	−0.2896	0.1466	0.2528
0.7071	−0.3220	0.2528	−0.3647	0.1766	0.2528
0.7915	−0.3124	0.2528	−0.4364	0.2073	0.2528
0.8728	−0.3013	0.2528	−0.5048	0.2385	0.2528
0.9509	−0.2891	0.2528	−0.5701	0.2701	0.2528
1.0257	−0.2762	0.2528	−0.6325	0.3018	0.2528
1.0973	−0.2628	0.2528	−0.6916	0.3333	0.2528
1.1660	−0.2492	0.2528	−0.7479	0.3642	0.2528
1.2314	−0.2355	0.2528	−0.7991	0.3929	0.2528
1.2908	−0.2227	0.2528	−0.8452	0.4193	0.2528
1.3442	−0.2110	0.2528	−0.8864	0.4431	0.2528
1.3918	−0.2008	0.2528	−0.9228	0.4639	0.2528
1.4364	−0.1916	0.2528	−0.9544	0.4817	0.2528
1.4751	−0.1839	0.2528	−0.9815	0.4963	0.2528
1.5050	−0.1780	0.2528	−1.0047	0.5085	0.2528
1.5288	−0.1735	0.2528	−1.0245	0.5182	0.2528
1.5468	−0.1700	0.2528	−1.0413	0.5252	0.2528
1.5591	−0.1647	0.2528	−1.0550	0.5299	0.2528
1.5633	−0.1584	0.2528	−1.0659	0.5324	0.2528
1.5644	−0.1536	0.2528	−1.0742	0.5331	0.2528
1.5645	−0.1512	0.2528	−1.0812	0.5324	0.2528
1.5644	−0.1500	0.2528	−1.0865	0.5305	0.2528
−1.0802	0.5476	0.4940	1.5721	−0.0612	0.4940
−1.0829	0.5440	0.4940	1.5720	−0.0606	0.4940
−1.0851	0.5383	0.4940	1.5718	−0.0595	0.4940
−1.0859	0.5308	0.4940	1.5712	−0.0573	0.4940
−1.0851	0.5217	0.4940	1.5691	−0.0535	0.4940
−1.0823	0.5099	0.4940	1.5641	−0.0486	0.4940
−1.0772	0.4952	0.4940	1.5521	−0.0460	0.4940
−1.0691	0.4775	0.4940	1.5355	−0.0476	0.4940
−1.0576	0.4565	0.4940	1.5134	−0.0494	0.4940
−1.0430	0.4324	0.4940	1.4857	−0.0515	0.4940
−1.0249	0.4049	0.4940	1.4498	−0.0538	0.4940
−1.0018	0.3735	0.4940	1.4082	−0.0560	0.4940
−0.9737	0.3387	0.4940	1.3639	−0.0572	0.4940
−0.9404	0.3001	0.4940	1.3141	−0.0578	0.4940
−0.9010	0.2591	0.4940	1.2587	−0.0573	0.4940
−0.8556	0.2160	0.4940	1.1978	−0.0561	0.4940
−0.8042	0.1708	0.4940	1.1341	−0.0537	0.4940
−0.7486	0.1263	0.4940	1.0678	−0.0501	0.4940
−0.6885	0.0826	0.4940	0.9989	−0.0454	0.4940
−0.6239	0.0398	0.4940	0.9274	−0.0393	0.4940
−0.5546	−0.0018	0.4940	0.8533	−0.0319	0.4940
−0.4812	−0.0413	0.4940	0.7767	−0.0231	0.4940
−0.4035	−0.0785	0.4940	0.6976	−0.0127	0.4940
−0.3216	−0.1131	0.4940	0.6159	−0.0006	0.4940
−0.2380	−0.1438	0.4940	0.5345	0.0128	0.4940
−0.1525	−0.1704	0.4940	0.4533	0.0275	0.4940
−0.0658	−0.1929	0.4940	0.3723	0.0435	0.4940
0.0216	−0.2112	0.4940	0.2915	0.0608	0.4940
0.1094	−0.2252	0.4940	0.2110	0.0793	0.4940
0.1977	−0.2354	0.4940	0.1306	0.0990	0.4940
0.2862	−0.2418	0.4940	0.0503	0.1195	0.4940
0.3753	−0.2449	0.4940	−0.0297	0.1414	0.4940
0.4646	−0.2449	0.4940	−0.1094	0.1647	0.4940
0.5541	−0.2420	0.4940	−0.1886	0.1891	0.4940

TABLE 1-continued

SUCTION SIDE			PRESSURE SIDE		
X	Y	Z	X	Y	Z
0.6434	−0.2363	0.4940	−0.2673	0.2151	0.4940
0.7295	−0.2285	0.4940	−0.3428	0.2418	0.4940
0.8125	−0.2191	0.4940	−0.4151	0.2691	0.4940
0.8924	−0.2083	0.4940	−0.4845	0.2970	0.4940
0.9691	−0.1964	0.4940	−0.5507	0.3250	0.4940
1.0426	−0.1839	0.4940	−0.6138	0.3530	0.4940
1.1130	−0.1709	0.4940	−0.6741	0.3810	0.4940
1.1804	−0.1577	0.4940	−0.7317	0.4085	0.4940
1.2447	−0.1446	0.4940	−0.7838	0.4339	0.4940
1.3031	−0.1323	0.4940	−0.8310	0.4572	0.4940
1.3557	−0.1210	0.4940	−0.8732	0.4782	0.4940
1.4024	−0.1112	0.4940	−0.9104	0.4964	0.4940
1.4463	−0.1023	0.4940	−0.9430	0.5118	0.4940
1.4844	−0.0949	0.4940	−0.9707	0.5244	0.4940
1.5137	−0.0893	0.4940	−0.9946	0.5350	0.4940
1.5373	−0.0850	0.4940	−1.0148	0.5431	0.4940
1.5548	−0.0816	0.4940	−1.0319	0.5489	0.4940
1.5668	−0.0762	0.4940	−1.0458	0.5522	0.4940
1.5709	−0.0700	0.4940	−1.0568	0.5537	0.4940
1.5721	−0.0654	0.4940	−1.0650	0.5538	0.4940
1.5722	−0.0629	0.4940	−1.0719	0.5526	0.4940
1.5722	−0.0617	0.4940	−1.0769	0.5503	0.4940
−1.0725	0.5794	0.7352	1.5792	0.0126	0.7352
−1.0750	0.5756	0.7352	1.5791	0.0131	0.7352
−1.0768	0.5700	0.7352	1.5789	0.0143	0.7352
−1.0771	0.5624	0.7352	1.5782	0.0163	0.7352
−1.0759	0.5535	0.7352	1.5762	0.0204	0.7352
−1.0725	0.5421	0.7352	1.5714	0.0251	0.7352
−1.0666	0.5278	0.7352	1.5594	0.0277	0.7352
−1.0576	0.5107	0.7352	1.5429	0.0265	0.7352
−1.0451	0.4908	0.7352	1.5209	0.0249	0.7352
−1.0293	0.4679	0.7352	1.4934	0.0230	0.7352
−1.0098	0.4417	0.7352	1.4575	0.0209	0.7352
−0.9855	0.4120	0.7352	1.4162	0.0192	0.7352
−0.9559	0.3789	0.7352	1.3722	0.0183	0.7352
−0.9210	0.3427	0.7352	1.3225	0.0182	0.7352
−0.8801	0.3038	0.7352	1.2674	0.0189	0.7352
−0.8333	0.2633	0.7352	1.2070	0.0205	0.7352
−0.7805	0.2208	0.7352	1.1435	0.0232	0.7352
−0.7236	0.1791	0.7352	1.0776	0.0270	0.7352
−0.6625	0.1383	0.7352	1.0090	0.0319	0.7352
−0.5971	0.0983	0.7352	0.9379	0.0381	0.7352
−0.5271	0.0597	0.7352	0.8642	0.0456	0.7352
−0.4530	0.0230	0.7352	0.7880	0.0544	0.7352
−0.3750	−0.0116	0.7352	0.7092	0.0647	0.7352
−0.2930	−0.0435	0.7352	0.6280	0.0767	0.7352
−0.2095	−0.0717	0.7352	0.5469	0.0899	0.7352
−0.1247	−0.0961	0.7352	0.4661	0.1042	0.7352
−0.0386	−0.1166	0.7352	0.3854	0.1197	0.7352
0.0485	−0.1334	0.7352	0.3049	0.1364	0.7352
0.1357	−0.1462	0.7352	0.2247	0.1541	0.7352
0.2230	−0.1551	0.7352	0.1446	0.1726	0.7352
0.3104	−0.1608	0.7352	0.0645	0.1919	0.7352
0.3980	−0.1633	0.7352	−0.0153	0.2123	0.7352
0.4855	−0.1629	0.7352	−0.0949	0.2337	0.7352
0.5732	−0.1598	0.7352	−0.1743	0.2563	0.7352
0.6610	−0.1542	0.7352	−0.2531	0.2803	0.7352
0.7459	−0.1467	0.7352	−0.3290	0.3048	0.7352
0.8279	−0.1376	0.7352	−0.4016	0.3299	0.7352
0.9067	−0.1272	0.7352	−0.4714	0.3553	0.7352
0.9825	−0.1159	0.7352	−0.5382	0.3809	0.7352
1.0551	−0.1040	0.7352	−0.6020	0.4065	0.7352
1.1248	−0.0916	0.7352	−0.6629	0.4318	0.7352
1.1913	−0.0792	0.7352	−0.7211	0.4568	0.7352
1.2550	−0.0667	0.7352	−0.7740	0.4800	0.7352
1.3127	−0.0550	0.7352	−0.8218	0.5011	0.7352
1.3646	−0.0444	0.7352	−0.8646	0.5200	0.7352
1.4109	−0.0352	0.7352	−0.9025	0.5366	0.7352
1.4543	−0.0268	0.7352	−0.9353	0.5505	0.7352
1.4919	−0.0199	0.7352	−0.9634	0.5618	0.7352
1.5209	−0.0147	0.7352	−0.9877	0.5709	0.7352
1.5443	−0.0106	0.7352	−1.0082	0.5780	0.7352
1.5616	−0.0074	0.7352	−1.0253	0.5834	0.7352
1.5737	−0.0024	0.7352	−1.0391	0.5869	0.7352
1.5779	0.0038	0.7352	−1.0499	0.5879	0.7352
1.5791	0.0083	0.7352	−1.0582	0.5871	0.7352

TABLE 1-continued

SUCTION SIDE			PRESSURE SIDE		
X	Y	Z	X	Y	Z
1.5792	0.0108	0.7352	−1.0648	0.5851	0.7352
1.5792	0.0120	0.7352	−1.0694	0.5823	0.7352
−1.0670	0.6243	0.9764	1.5853	0.0585	0.9764
−1.0695	0.6206	0.9764	1.5852	0.0590	0.9764
−1.0712	0.6148	0.9764	1.5850	0.0601	0.9764
−1.0716	0.6073	0.9764	1.5844	0.0623	0.9764
−1.0702	0.5985	0.9764	1.5825	0.0662	0.9764
−1.0662	0.5871	0.9764	1.5776	0.0711	0.9764
−1.0593	0.5734	0.9764	1.5657	0.0738	0.9764
−1.0493	0.5568	0.9764	1.5492	0.0727	0.9764
−1.0363	0.5373	0.9764	1.5272	0.0714	0.9764
−1.0199	0.5150	0.9764	1.4997	0.0699	0.9764
−0.9997	0.4897	0.9764	1.4639	0.0684	0.9764
−0.9744	0.4608	0.9764	1.4226	0.0672	0.9764
−0.9440	0.4287	0.9764	1.3785	0.0668	0.9764
−0.9081	0.3935	0.9764	1.3290	0.0674	0.9764
−0.8665	0.3560	0.9764	1.2739	0.0687	0.9764
−0.8191	0.3167	0.9764	1.2135	0.0710	0.9764
−0.7658	0.2758	0.9764	1.1502	0.0743	0.9764
−0.7086	0.2355	0.9764	1.0843	0.0787	0.9764
−0.6473	0.1961	0.9764	1.0159	0.0843	0.9764
−0.5819	0.1575	0.9764	0.9449	0.0910	0.9764
−0.5122	0.1201	0.9764	0.8712	0.0989	0.9764
−0.4379	0.0844	0.9764	0.7952	0.1084	0.9764
−0.3597	0.0507	0.9764	0.7166	0.1193	0.9764
−0.2777	0.0194	0.9764	0.6354	0.1317	0.9764
−0.1946	−0.0083	0.9764	0.5545	0.1454	0.9764
−0.1104	−0.0324	0.9764	0.4737	0.1601	0.9764
−0.0250	−0.0529	0.9764	0.3932	0.1760	0.9764
0.0615	−0.0697	0.9764	0.3129	0.1928	0.9764
0.1488	−0.0829	0.9764	0.2328	0.2106	0.9764
0.2360	−0.0924	0.9764	0.1526	0.2292	0.9764
0.3232	−0.0986	0.9764	0.0727	0.2485	0.9764
0.4103	−0.1017	0.9764	−0.0070	0.2686	0.9764
0.4975	−0.1019	0.9764	−0.0867	0.2896	0.9764
0.5845	−0.0997	0.9764	−0.1660	0.3118	0.9764
0.6715	−0.0950	0.9764	−0.2451	0.3352	0.9764
0.7557	−0.0885	0.9764	−0.3210	0.3593	0.9764
0.8369	−0.0803	0.9764	−0.3938	0.3837	0.9764
0.9152	−0.0710	0.9764	−0.4636	0.4084	0.9764
0.9906	−0.0607	0.9764	−0.5307	0.4331	0.9764
1.0629	−0.0497	0.9764	−0.5947	0.4579	0.9764
1.1323	−0.0384	0.9764	−0.6559	0.4823	0.9764
1.1987	−0.0269	0.9764	−0.7143	0.5064	0.9764
1.2621	−0.0154	0.9764	−0.7676	0.5288	0.9764
1.3196	−0.0048	0.9764	−0.8156	0.5492	0.9764
1.3714	0.0051	0.9764	−0.8586	0.5675	0.9764
1.4175	0.0135	0.9764	−0.8967	0.5834	0.9764
1.4607	0.0213	0.9764	−0.9297	0.5971	0.9764
1.4983	0.0275	0.9764	−0.9579	0.6079	0.9764
1.5272	0.0322	0.9764	−0.9821	0.6167	0.9764
1.5503	0.0361	0.9764	−1.0027	0.6235	0.9764
1.5677	0.0388	0.9764	−1.0198	0.6288	0.9764
1.5797	0.0437	0.9764	−1.0337	0.6320	0.9764
1.5840	0.0497	0.9764	−1.0446	0.6330	0.9764
1.5853	0.0543	0.9764	−1.0528	0.6321	0.9764
1.5854	0.0567	0.9764	−1.0594	0.6301	0.9764
1.5853	0.0580	0.9764	−1.0641	0.6272	0.9764
−1.0665	0.6653	1.2176	1.5908	0.0789	1.2176
−1.0690	0.6615	1.2176	1.5907	0.0794	1.2176
−1.0707	0.6557	1.2176	1.5906	0.0805	1.2176
−1.0709	0.6482	1.2176	1.5901	0.0826	1.2176
−1.0693	0.6394	1.2176	1.5880	0.0866	1.2176
−1.0651	0.6283	1.2176	1.5833	0.0915	1.2176
−1.0578	0.6147	1.2176	1.5714	0.0943	1.2176
−1.0473	0.5985	1.2176	1.5548	0.0934	1.2176
−1.0340	0.5792	1.2176	1.5329	0.0923	1.2176
−1.0173	0.5571	1.2176	1.5053	0.0911	1.2176
−0.9965	0.5323	1.2176	1.4694	0.0900	1.2176
−0.9707	0.5038	1.2176	1.4281	0.0894	1.2176
−0.9397	0.4720	1.2176	1.3841	0.0896	1.2176
−0.9035	0.4373	1.2176	1.3346	0.0905	1.2176
−0.8616	0.4004	1.2176	1.2795	0.0925	1.2176
−0.8140	0.3615	1.2176	1.2190	0.0955	1.2176
−0.7604	0.3211	1.2176	1.1558	0.0993	1.2176
−0.7029	0.2810	1.2176	1.0899	0.1044	1.2176

TABLE 1-continued

SUCTION SIDE			PRESSURE SIDE		
X	Y	Z	X	Y	Z
−0.6412	0.2417	1.2176	1.0213	0.1105	1.2176
−0.5753	0.2031	1.2176	0.9502	0.1180	1.2176
−0.5053	0.1657	1.2176	0.8764	0.1267	1.2176
−0.4312	0.1299	1.2176	0.8001	0.1368	1.2176
−0.3534	0.0961	1.2176	0.7212	0.1486	1.2176
−0.2718	0.0645	1.2176	0.6398	0.1619	1.2176
−0.1892	0.0363	1.2176	0.5586	0.1763	1.2176
−0.1055	0.0115	1.2176	0.4775	0.1918	1.2176
−0.0207	−0.0098	1.2176	0.3965	0.2084	1.2176
0.0652	−0.0277	1.2176	0.3158	0.2260	1.2176
0.1522	−0.0420	1.2176	0.2354	0.2444	1.2176
0.2398	−0.0529	1.2176	0.1550	0.2635	1.2176
0.3273	−0.0602	1.2176	0.0748	0.2834	1.2176
0.4147	−0.0646	1.2176	−0.0051	0.3039	1.2176
0.5020	−0.0660	1.2176	−0.0849	0.3255	1.2176
0.5893	−0.0650	1.2176	−0.1642	0.3481	1.2176
0.6764	−0.0615	1.2176	−0.2433	0.3721	1.2176
0.7606	−0.0561	1.2176	−0.3193	0.3965	1.2176
0.8418	−0.0491	1.2176	−0.3923	0.4213	1.2176
0.9201	−0.0408	1.2176	−0.4623	0.4462	1.2176
0.9953	−0.0316	1.2176	−0.5293	0.4712	1.2176
1.0677	−0.0217	1.2176	−0.5935	0.4962	1.2176
1.1372	−0.0114	1.2176	−0.6548	0.5209	1.2176
1.2036	−0.0009	1.2176	−0.7133	0.5453	1.2176
1.2673	0.0096	1.2176	−0.7666	0.5677	1.2176
1.3250	0.0196	1.2176	−0.8147	0.5883	1.2176
1.3768	0.0285	1.2176	−0.8577	0.6067	1.2176
1.4230	0.0364	1.2176	−0.8958	0.6229	1.2176
1.4664	0.0434	1.2176	−0.9289	0.6366	1.2176
1.5040	0.0493	1.2176	−0.9571	0.6478	1.2176
1.5329	0.0536	1.2176	−0.9813	0.6568	1.2176
1.5561	0.0570	1.2176	−1.0019	0.6638	1.2176
1.5735	0.0597	1.2176	−1.0191	0.6691	1.2176
1.5853	0.0644	1.2176	−1.0330	0.6722	1.2176
1.5896	0.0703	1.2176	−1.0438	0.6732	1.2176
1.5908	0.0747	1.2176	−1.0522	0.6727	1.2176
1.5910	0.0771	1.2176	−1.0587	0.6709	1.2176
1.5909	0.0783	1.2176	−1.0636	0.6681	1.2176
−1.0786	0.7029	1.7000	1.6049	0.0616	1.7000
−1.0810	0.6990	1.7000	1.6048	0.0623	1.7000
−1.0825	0.6932	1.7000	1.6046	0.0633	1.7000
−1.0822	0.6856	1.7000	1.6040	0.0655	1.7000
−1.0803	0.6767	1.7000	1.6020	0.0695	1.7000
−1.0760	0.6655	1.7000	1.5970	0.0744	1.7000
−1.0685	0.6519	1.7000	1.5849	0.0769	1.7000
−1.0578	0.6356	1.7000	1.5681	0.0762	1.7000
−1.0440	0.6164	1.7000	1.5459	0.0752	1.7000
−1.0267	0.5944	1.7000	1.5179	0.0743	1.7000
−1.0054	0.5693	1.7000	1.4815	0.0735	1.7000
−0.9791	0.5408	1.7000	1.4396	0.0733	1.7000
−0.9477	0.5089	1.7000	1.3949	0.0740	1.7000
−0.9109	0.4740	1.7000	1.3447	0.0756	1.7000
−0.8688	0.4365	1.7000	1.2889	0.0782	1.7000
−0.8208	0.3970	1.7000	1.2274	0.0817	1.7000
−0.7667	0.3558	1.7000	1.1634	0.0864	1.7000
−0.7090	0.3149	1.7000	1.0966	0.0923	1.7000
−0.6471	0.2745	1.7000	1.0271	0.0993	1.7000
−0.5811	0.2348	1.7000	0.9551	0.1078	1.7000
−0.5109	0.1960	1.7000	0.8804	0.1176	1.7000
−0.4365	0.1584	1.7000	0.8031	0.1289	1.7000
−0.3585	0.1227	1.7000	0.7233	0.1418	1.7000
−0.2766	0.0889	1.7000	0.6409	0.1563	1.7000
−0.1938	0.0584	1.7000	0.5587	0.1721	1.7000
−0.1099	0.0312	1.7000	0.4766	0.1891	1.7000
−0.0249	0.0074	1.7000	0.3947	0.2070	1.7000
0.0610	−0.0133	1.7000	0.3130	0.2259	1.7000
0.1481	−0.0303	1.7000	0.2316	0.2454	1.7000
0.2364	−0.0439	1.7000	0.1505	0.2658	1.7000
0.3249	−0.0538	1.7000	0.0694	0.2869	1.7000
0.4134	−0.0607	1.7000	−0.0114	0.3089	1.7000
0.5018	−0.0644	1.7000	−0.0920	0.3321	1.7000
0.5901	−0.0655	1.7000	−0.1722	0.3566	1.7000
0.6783	−0.0641	1.7000	−0.2518	0.3824	1.7000
0.7634	−0.0605	1.7000	−0.3284	0.4087	1.7000
0.8455	−0.0552	1.7000	−0.4018	0.4355	1.7000
0.9248	−0.0485	1.7000	−0.4722	0.4625	1.7000

TABLE 1-continued

SUCTION SIDE			PRESSURE SIDE		
X	Y	Z	X	Y	Z
1.0009	−0.0406	1.7000	−0.5395	0.4894	1.7000
1.0742	−0.0319	1.7000	−0.6041	0.5163	1.7000
1.1444	−0.0228	1.7000	−0.6655	0.5430	1.7000
1.2117	−0.0133	1.7000	−0.7242	0.5692	1.7000
1.2761	−0.0038	1.7000	−0.7777	0.5937	1.7000
1.3346	0.0054	1.7000	−0.8259	0.6159	1.7000
1.3872	0.0137	1.7000	−0.8689	0.6358	1.7000
1.4340	0.0210	1.7000	−0.9070	0.6534	1.7000
1.4779	0.0275	1.7000	−0.9401	0.6684	1.7000
1.5160	0.0329	1.7000	−0.9682	0.6808	1.7000
1.5452	0.0371	1.7000	−0.9925	0.6909	1.7000
1.5687	0.0403	1.7000	−1.0131	0.6989	1.7000
1.5862	0.0427	1.7000	−1.0303	0.7048	1.7000
1.5987	0.0469	1.7000	−1.0443	0.7083	1.7000
1.6033	0.0529	1.7000	−1.0553	0.7099	1.7000
1.6047	0.0574	1.7000	−1.0637	0.7098	1.7000
1.6049	0.0598	1.7000	−1.0706	0.7082	1.7000
1.6049	0.0610	1.7000	−1.0756	0.7057	1.7000
−1.0857	0.6807	1.9412	1.6123	0.0182	1.9412
−1.0882	0.6767	1.9412	1.6122	0.0188	1.9412
−1.0895	0.6708	1.9412	1.6120	0.0199	1.9412
−1.0893	0.6632	1.9412	1.6114	0.0221	1.9412
−1.0872	0.6543	1.9412	1.6093	0.0260	1.9412
−1.0827	0.6431	1.9412	1.6043	0.0309	1.9412
−1.0753	0.6294	1.9412	1.5921	0.0332	1.9412
−1.0646	0.6129	1.9412	1.5751	0.0324	1.9412
−1.0506	0.5936	1.9412	1.5526	0.0315	1.9412
−1.0332	0.5714	1.9412	1.5244	0.0305	1.9412
−1.0117	0.5463	1.9412	1.4878	0.0297	1.9412
−0.9853	0.5175	1.9412	1.4456	0.0294	1.9412
−0.9537	0.4852	1.9412	1.4005	0.0301	1.9412
−0.9169	0.4500	1.9412	1.3499	0.0316	1.9412
−0.8745	0.4121	1.9412	1.2936	0.0342	1.9412
−0.8265	0.3720	1.9412	1.2318	0.0378	1.9412
−0.7724	0.3302	1.9412	1.1672	0.0424	1.9412
−0.7144	0.2887	1.9412	1.0999	0.0483	1.9412
−0.6526	0.2474	1.9412	1.0299	0.0555	1.9412
−0.5866	0.2068	1.9412	0.9572	0.0640	1.9412
−0.5161	0.1672	1.9412	0.8820	0.0738	1.9412
−0.4416	0.1287	1.9412	0.8042	0.0853	1.9412
−0.3633	0.0919	1.9412	0.7237	0.0984	1.9412
−0.2811	0.0572	1.9412	0.6406	0.1132	1.9412
−0.1980	0.0257	1.9412	0.5578	0.1293	1.9412
−0.1139	−0.0026	1.9412	0.4750	0.1464	1.9412
−0.0286	−0.0275	1.9412	0.3927	0.1647	1.9412
0.0578	−0.0493	1.9412	0.3105	0.1838	1.9412
0.1452	−0.0674	1.9412	0.2285	0.2037	1.9412
0.2338	−0.0820	1.9412	0.1466	0.2244	1.9412
0.3230	−0.0931	1.9412	0.0651	0.2459	1.9412
0.4121	−0.1006	1.9412	−0.0163	0.2685	1.9412
0.5011	−0.1052	1.9412	−0.0974	0.2923	1.9412
0.5900	−0.1069	1.9412	−0.1779	0.3176	1.9412
0.6789	−0.1060	1.9412	−0.2580	0.3444	1.9412
0.7646	−0.1028	1.9412	−0.3347	0.3717	1.9412
0.8473	−0.0979	1.9412	−0.4085	0.3995	1.9412
0.9271	−0.0914	1.9412	−0.4790	0.4275	1.9412
1.0038	−0.0838	1.9412	−0.5465	0.4556	1.9412
1.0777	−0.0754	1.9412	−0.6111	0.4836	1.9412
1.1484	−0.0664	1.9412	−0.6727	0.5115	1.9412
1.2162	−0.0570	1.9412	−0.7314	0.5387	1.9412
1.2810	−0.0475	1.9412	−0.7848	0.5642	1.9412
1.3398	−0.0384	1.9412	−0.8330	0.5875	1.9412
1.3929	−0.0301	1.9412	−0.8760	0.6085	1.9412
1.4400	−0.0226	1.9412	−0.9140	0.6269	1.9412
1.4841	−0.0160	1.9412	−0.9469	0.6427	1.9412
1.5225	−0.0105	1.9412	−0.9751	0.6558	1.9412
1.5521	−0.0065	1.9412	−0.9992	0.6665	1.9412
1.5757	−0.0031	1.9412	−1.0198	0.6750	1.9412
1.5934	−0.0006	1.9412	−1.0370	0.6813	1.9412
1.6060	0.0034	1.9412	−1.0511	0.6852	1.9412
1.6107	0.0092	1.9412	−1.0622	0.6871	1.9412
1.6121	0.0139	1.9412	−1.0707	0.6872	1.9412
1.6124	0.0163	1.9412	−1.0776	0.6859	1.9412
1.6123	0.0175	1.9412	−1.0827	0.6836	1.9412
−1.0955	0.6408	2.1824	1.6234	−0.0367	2.1824
−1.0979	0.6368	2.1824	1.6234	−0.0360	2.1824

TABLE 1-continued

SUCTION SIDE			PRESSURE SIDE		
X	Y	Z	X	Y	Z
−1.0992	0.6309	2.1824	1.6231	−0.0349	2.1824
−1.0987	0.6232	2.1824	1.6225	−0.0327	2.1824
−1.0965	0.6142	2.1824	1.6204	−0.0287	2.1824
−1.0919	0.6030	2.1824	1.6152	−0.0239	2.1824
−1.0844	0.5891	2.1824	1.6028	−0.0218	2.1824
−1.0735	0.5725	2.1824	1.5857	−0.0228	2.1824
−1.0594	0.5530	2.1824	1.5629	−0.0239	2.1824
−1.0417	0.5308	2.1824	1.5346	−0.0250	2.1824
−1.0200	0.5054	2.1824	1.4975	−0.0260	2.1824
−0.9933	0.4766	2.1824	1.4550	−0.0266	2.1824
−0.9614	0.4440	2.1824	1.4095	−0.0261	2.1824
−0.9241	0.4085	2.1824	1.3583	−0.0249	2.1824
−0.8816	0.3703	2.1824	1.3015	−0.0226	2.1824
−0.8332	0.3298	2.1824	1.2391	−0.0194	2.1824
−0.7787	0.2875	2.1824	1.1738	−0.0149	2.1824
−0.7204	0.2454	2.1824	1.1059	−0.0093	2.1824
−0.6581	0.2037	2.1824	1.0351	−0.0024	2.1824
−0.5917	0.1626	2.1824	0.9619	0.0058	2.1824
−0.5211	0.1222	2.1824	0.8859	0.0155	2.1824
−0.4460	0.0830	2.1824	0.8072	0.0268	2.1824
−0.3672	0.0455	2.1824	0.7259	0.0398	2.1824
−0.2846	0.0100	2.1824	0.6419	0.0545	2.1824
−0.2009	−0.0223	2.1824	0.5581	0.0704	2.1824
−0.1163	−0.0512	2.1824	0.4747	0.0877	2.1824
−0.0305	−0.0772	2.1824	0.3914	0.1058	2.1824
0.0564	−0.0997	2.1824	0.3084	0.1250	2.1824
0.1443	−0.1186	2.1824	0.2256	0.1449	2.1824
0.2335	−0.1341	2.1824	0.1429	0.1657	2.1824
0.3235	−0.1460	2.1824	0.0605	0.1874	2.1824
0.4132	−0.1542	2.1824	−0.0216	0.2104	2.1824
0.5029	−0.1594	2.1824	−0.1033	0.2348	2.1824
0.5926	−0.1616	2.1824	−0.1844	0.2608	2.1824
0.6821	−0.1612	2.1824	−0.2649	0.2884	2.1824
0.7685	−0.1583	2.1824	−0.3422	0.3167	2.1824
0.8520	−0.1537	2.1824	−0.4163	0.3455	2.1824
0.9325	−0.1473	2.1824	−0.4871	0.3744	2.1824
1.0099	−0.1400	2.1824	−0.5550	0.4037	2.1824
1.0842	−0.1315	2.1824	−0.6199	0.4329	2.1824
1.1556	−0.1225	2.1824	−0.6816	0.4618	2.1824
1.2240	−0.1131	2.1824	−0.7405	0.4903	2.1824
1.2893	−0.1035	2.1824	−0.7939	0.5168	2.1824
1.3487	−0.0942	2.1824	−0.8421	0.5412	2.1824
1.4022	−0.0857	2.1824	−0.8853	0.5631	2.1824
1.4497	−0.0782	2.1824	−0.9232	0.5825	2.1824
1.4943	−0.0713	2.1824	−0.9563	0.5992	2.1824
1.5329	−0.0657	2.1824	−0.9842	0.6130	2.1824
1.5626	−0.0615	2.1824	−1.0085	0.6244	2.1824
1.5864	−0.0580	2.1824	−1.0290	0.6335	2.1824
1.6043	−0.0555	2.1824	−1.0463	0.6400	2.1824
1.6171	−0.0514	2.1824	−1.0603	0.6444	2.1824
1.6218	−0.0456	2.1824	−1.0716	0.6464	2.1824
1.6232	−0.0409	2.1824	−1.0801	0.6469	2.1824
1.6235	−0.0384	2.1824	−1.0871	0.6459	2.1824
1.6235	−0.0372	2.1824	−1.0924	0.6436	2.1824
−1.1309	0.5568	2.6648	1.6627	−0.1542	2.6648
−1.1333	0.5528	2.6648	1.6626	−0.1536	2.6648
−1.1345	0.5465	2.6648	1.6624	−0.1524	2.6648
−1.1338	0.5387	2.6648	1.6617	−0.1501	2.6648
−1.1313	0.5296	2.6648	1.6594	−0.1460	2.6648
−1.1263	0.5183	2.6648	1.6537	−0.1414	2.6648
−1.1181	0.5043	2.6648	1.6407	−0.1402	2.6648
−1.1066	0.4877	2.6648	1.6231	−0.1414	2.6648
−1.0912	0.4685	2.6648	1.5995	−0.1429	2.6648
−1.0725	0.4461	2.6648	1.5702	−0.1447	2.6648
−1.0497	0.4207	2.6648	1.5321	−0.1464	2.6648
−1.0218	0.3913	2.6648	1.4880	−0.1478	2.6648
−0.9889	0.3586	2.6648	1.4409	−0.1482	2.6648
−0.9503	0.3229	2.6648	1.3880	−0.1480	2.6648
−0.9064	0.2841	2.6648	1.3293	−0.1468	2.6648
−0.8567	0.2430	2.6648	1.2647	−0.1446	2.6648
−0.8005	0.1999	2.6648	1.1972	−0.1413	2.6648
−0.7404	0.1569	2.6648	1.1269	−0.1368	2.6648
−0.6762	0.1141	2.6648	1.0540	−0.1310	2.6648
−0.6079	0.0718	2.6648	0.9783	−0.1237	2.6648
−0.5353	0.0303	2.6648	0.8998	−0.1149	2.6648
−0.4590	−0.0098	2.6648	0.8186	−0.1044	2.6648

TABLE 1-continued

SUCTION SIDE			PRESSURE SIDE		
X	Y	Z	X	Y	Z
−0.3788	−0.0483	2.6648	0.7348	−0.0922	2.6648
−0.2947	−0.0850	2.6648	0.6483	−0.0782	2.6648
−0.2093	−0.1186	2.6648	0.5620	−0.0626	2.6648
−0.1228	−0.1492	2.6648	0.4757	−0.0459	2.6648
−0.0352	−0.1768	2.6648	0.3898	−0.0278	2.6648
0.0536	−0.2011	2.6648	0.3041	−0.0087	2.6648
0.1437	−0.2221	2.6648	0.2185	0.0115	2.6648
0.2349	−0.2396	2.6648	0.1330	0.0328	2.6648
0.3265	−0.2533	2.6648	0.0481	0.0554	2.6648
0.4181	−0.2634	2.6648	−0.0364	0.0796	2.6648
0.5098	−0.2703	2.6648	−0.1202	0.1056	2.6648
0.6016	−0.2741	2.6648	−0.2033	0.1336	2.6648
0.6936	−0.2751	2.6648	−0.2859	0.1635	2.6648
0.7827	−0.2736	2.6648	−0.3651	0.1942	2.6648
0.8687	−0.2700	2.6648	−0.4409	0.2257	2.6648
0.9517	−0.2646	2.6648	−0.5135	0.2575	2.6648
1.0316	−0.2579	2.6648	−0.5828	0.2896	2.6648
1.1084	−0.2500	2.6648	−0.6488	0.3217	2.6648
1.1819	−0.2415	2.6648	−0.7116	0.3534	2.6648
1.2524	−0.2321	2.6648	−0.7714	0.3849	2.6648
1.3197	−0.2227	2.6648	−0.8256	0.4142	2.6648
1.3808	−0.2135	2.6648	−0.8745	0.4412	2.6648
1.4357	−0.2048	2.6648	−0.9181	0.4656	2.6648
1.4844	−0.1970	2.6648	−0.9564	0.4871	2.6648
1.5303	−0.1900	2.6648	−0.9898	0.5058	2.6648
1.5699	−0.1839	2.6648	−1.0181	0.5214	2.6648
1.6004	−0.1794	2.6648	−1.0423	0.5346	2.6648
1.6249	−0.1757	2.6648	−1.0629	0.5454	2.6648
1.6431	−0.1729	2.6648	−1.0803	0.5534	2.6648
1.6563	−0.1691	2.6648	−1.0945	0.5586	2.6648
1.6612	−0.1631	2.6648	−1.1060	0.5614	2.6648
1.6626	−0.1585	2.6648	−1.1147	0.5623	2.6648
1.6628	−0.1560	2.6648	−1.1220	0.5616	2.6648
1.6627	−0.1547	2.6648	−1.1275	0.5596	2.6648
−1.1554	0.5163	2.9061	1.6893	−0.2171	2.9061
−1.1578	0.5121	2.9061	1.6893	−0.2165	2.9061
−1.1588	0.5057	2.9061	1.6892	−0.2153	2.9061
−1.1579	0.4978	2.9061	1.6884	−0.2130	2.9061
−1.1552	0.4888	2.9061	1.6859	−0.2088	2.9061
−1.1497	0.4772	2.9061	1.6800	−0.2043	2.9061
−1.1411	0.4631	2.9061	1.6666	−0.2035	2.9061
−1.1289	0.4467	2.9061	1.6486	−0.2050	2.9061
−1.1129	0.4275	2.9061	1.6247	−0.2068	2.9061
−1.0934	0.4051	2.9061	1.5948	−0.2089	2.9061
−1.0698	0.3796	2.9061	1.5558	−0.2111	2.9061
−1.0411	0.3501	2.9061	1.5108	−0.2130	2.9061
−1.0073	0.3172	2.9061	1.4628	−0.2140	2.9061
−0.9678	0.2812	2.9061	1.4089	−0.2144	2.9061
−0.9229	0.2422	2.9061	1.3489	−0.2140	2.9061
−0.8718	0.2005	2.9061	1.2829	−0.2125	2.9061
−0.8144	0.1569	2.9061	1.2140	−0.2099	2.9061
−0.7529	0.1132	2.9061	1.1424	−0.2060	2.9061
−0.6873	0.0698	2.9061	1.0678	−0.2008	2.9061
−0.6176	0.0269	2.9061	0.9904	−0.1941	2.9061
−0.5441	−0.0151	2.9061	0.9103	−0.1859	2.9061
−0.4668	−0.0557	2.9061	0.8274	−0.1759	2.9061
−0.3855	−0.0949	2.9061	0.7417	−0.1641	2.9061
−0.3000	−0.1324	2.9061	0.6533	−0.1502	2.9061
−0.2133	−0.1669	2.9061	0.5651	−0.1349	2.9061
−0.1252	−0.1983	2.9061	0.4771	−0.1181	2.9061
−0.0359	−0.2268	2.9061	0.3892	−0.1000	2.9061
0.0546	−0.2522	2.9061	0.3016	−0.0806	2.9061
0.1464	−0.2744	2.9061	0.2140	−0.0600	2.9061
0.2387	−0.2928	2.9061	0.1269	−0.0382	2.9061
0.3311	−0.3075	2.9061	0.0402	−0.0150	2.9061
0.4238	−0.3187	2.9061	−0.0459	0.0103	2.9061
0.5168	−0.3265	2.9061	−0.1315	0.0376	2.9061
0.6100	−0.3313	2.9061	−0.2164	0.0669	2.9061
0.7033	−0.3333	2.9061	−0.3006	0.0984	2.9061
0.7938	−0.3326	2.9061	−0.3813	0.1307	2.9061
0.8812	−0.3298	2.9061	−0.4583	0.1638	2.9061
0.9658	−0.3253	2.9061	−0.5317	0.1973	2.9061
1.0471	−0.3192	2.9061	−0.6018	0.2311	2.9061
1.1251	−0.3119	2.9061	−0.6687	0.2649	2.9061
1.2000	−0.3036	2.9061	−0.7323	0.2984	2.9061
1.2717	−0.2949	2.9061	−0.7928	0.3316	2.9061

TABLE 1-continued

SUCTION SIDE			PRESSURE SIDE		
X	Y	Z	X	Y	Z
1.3400	−0.2858	2.9061	−0.8476	0.3624	2.9061
1.4021	−0.2767	2.9061	−0.8969	0.3910	2.9061
1.4579	−0.2683	2.9061	−0.9408	0.4168	2.9061
1.5076	−0.2606	2.9061	−0.9796	0.4397	2.9061
1.5541	−0.2534	2.9061	−1.0131	0.4594	2.9061
1.5944	−0.2473	2.9061	−1.0416	0.4761	2.9061
1.6255	−0.2426	2.9061	−1.0659	0.4904	2.9061
1.6503	−0.2388	2.9061	−1.0865	0.5021	2.9061
1.6690	−0.2360	2.9061	−1.1039	0.5108	2.9061
1.6824	−0.2323	2.9061	−1.1183	0.5168	2.9061
1.6877	−0.2264	2.9061	−1.1298	0.5201	2.9061
1.6893	−0.2215	2.9061	−1.1387	0.5212	2.9061
1.6895	−0.2190	2.9061	−1.1462	0.5210	2.9061
1.6895	−0.2178	2.9061	−1.1519	0.5190	2.9061
−1.1715	0.4717	3.1473	1.7025	−0.2804	3.1473
−1.1739	0.4675	3.1473	1.7024	−0.2799	3.1473
−1.1747	0.4610	3.1473	1.7022	−0.2787	3.1473
−1.1736	0.4531	3.1473	1.7014	−0.2764	3.1473
−1.1704	0.4439	3.1473	1.6989	−0.2722	3.1473
−1.1648	0.4325	3.1473	1.6927	−0.2678	3.1473
−1.1559	0.4184	3.1473	1.6791	−0.2673	3.1473
−1.1433	0.4019	3.1473	1.6609	−0.2690	3.1473
−1.1270	0.3828	3.1473	1.6367	−0.2711	3.1473
−1.1069	0.3605	3.1473	1.6064	−0.2736	3.1473
−1.0828	0.3351	3.1473	1.5670	−0.2762	3.1473
−1.0536	0.3056	3.1473	1.5215	−0.2785	3.1473
−1.0192	0.2727	3.1473	1.4730	−0.2801	3.1473
−0.9791	0.2366	3.1473	1.4184	−0.2812	3.1473
−0.9335	0.1974	3.1473	1.3576	−0.2815	3.1473
−0.8816	0.1556	3.1473	1.2909	−0.2808	3.1473
−0.8234	0.1116	3.1473	1.2211	−0.2788	3.1473
−0.7611	0.0676	3.1473	1.1485	−0.2757	3.1473
−0.6948	0.0238	3.1473	1.0726	−0.2710	3.1473
−0.6247	−0.0193	3.1473	0.9940	−0.2649	3.1473
−0.5508	−0.0615	3.1473	0.9126	−0.2571	3.1473
−0.4729	−0.1025	3.1473	0.8284	−0.2476	3.1473
−0.3909	−0.1421	3.1473	0.7413	−0.2359	3.1473
−0.3046	−0.1803	3.1473	0.6517	−0.2223	3.1473
−0.2171	−0.2154	3.1473	0.5622	−0.2070	3.1473
−0.1282	−0.2475	3.1473	0.4729	−0.1902	3.1473
−0.0380	−0.2768	3.1473	0.3839	−0.1720	3.1473
0.0536	−0.3031	3.1473	0.2949	−0.1525	3.1473
0.1458	−0.3261	3.1473	0.2064	−0.1316	3.1473
0.2383	−0.3455	3.1473	0.1182	−0.1095	3.1473
0.3313	−0.3613	3.1473	0.0306	−0.0853	3.1473
0.4245	−0.3735	3.1473	−0.0564	−0.0591	3.1473
0.5181	−0.3824	3.1473	−0.1426	−0.0307	3.1473
0.6120	−0.3882	3.1473	−0.2282	−0.0001	3.1473
0.7063	−0.3910	3.1473	−0.3130	0.0328	3.1473
0.7977	−0.3913	3.1473	−0.3944	0.0666	3.1473
0.8861	−0.3893	3.1473	−0.4720	0.1011	3.1473
0.9714	−0.3856	3.1473	−0.5459	0.1361	3.1473
1.0536	−0.3802	3.1473	−0.6164	0.1714	3.1473
1.1325	−0.3735	3.1473	−0.6836	0.2066	3.1473
1.2081	−0.3659	3.1473	−0.7475	0.2417	3.1473
1.2804	−0.3576	3.1473	−0.8082	0.2763	3.1473
1.3496	−0.3488	3.1473	−0.8631	0.3086	3.1473
1.4124	−0.3400	3.1473	−0.9125	0.3384	3.1473
1.4688	−0.3317	3.1473	−0.9565	0.3653	3.1473
1.5189	−0.3241	3.1473	−0.9953	0.3892	3.1473
1.5659	−0.3169	3.1473	−1.0288	0.4102	3.1473
1.6065	−0.3108	3.1473	−1.0572	0.4277	3.1473
1.6378	−0.3060	3.1473	−1.0816	0.4427	3.1473
1.6630	−0.3022	3.1473	−1.1022	0.4550	3.1473
1.6817	−0.2993	3.1473	−1.1196	0.4643	3.1473
1.6954	−0.2957	3.1473	−1.1340	0.4706	3.1473
1.7008	−0.2898	3.1473	−1.1456	0.4744	3.1473
1.7024	−0.2850	3.1473	−1.1545	0.4760	3.1473
1.7026	−0.2824	3.1473	−1.1621	0.4761	3.1473
1.7025	−0.2810	3.1473	−1.1679	0.4745	3.1473
−1.1798	0.4259	3.3885	1.7039	−0.3447	3.3885
−1.1821	0.4216	3.3885	1.7038	−0.3440	3.3885
−1.1826	0.4151	3.3885	1.7035	−0.3429	3.3885
−1.1810	0.4073	3.3885	1.7028	−0.3404	3.3885
−1.1777	0.3982	3.3885	1.7001	−0.3363	3.3885
−1.1717	0.3868	3.3885	1.6938	−0.3321	3.3885

TABLE 1-continued

SUCTION SIDE			PRESSURE SIDE		
X	Y	Z	X	Y	Z
−1.1626	0.3730	3.3885	1.6801	−0.3319	3.3885
−1.1500	0.3565	3.3885	1.6619	−0.3337	3.3885
−1.1335	0.3376	3.3885	1.6376	−0.3360	3.3885
−1.1132	0.3155	3.3885	1.6071	−0.3388	3.3885
−1.0889	0.2902	3.3885	1.5675	−0.3419	3.3885
−1.0595	0.2611	3.3885	1.5216	−0.3447	3.3885
−1.0249	0.2283	3.3885	1.4728	−0.3469	3.3885
−0.9845	0.1924	3.3885	1.4179	−0.3484	3.3885
−0.9388	0.1532	3.3885	1.3568	−0.3493	3.3885
−0.8868	0.1113	3.3885	1.2897	−0.3491	3.3885
−0.8283	0.0672	3.3885	1.2194	−0.3478	3.3885
−0.7660	0.0231	3.3885	1.1462	−0.3451	3.3885
−0.7001	−0.0208	3.3885	1.0699	−0.3410	3.3885
−0.6302	−0.0641	3.3885	0.9908	−0.3351	3.3885
−0.5563	−0.1067	3.3885	0.9088	−0.3277	3.3885
−0.4784	−0.1482	3.3885	0.8240	−0.3184	3.3885
−0.3962	−0.1886	3.3885	0.7364	−0.3070	3.3885
−0.3097	−0.2275	3.3885	0.6461	−0.2935	3.3885
−0.2217	−0.2635	3.3885	0.5560	−0.2783	3.3885
−0.1322	−0.2966	3.3885	0.4661	−0.2614	3.3885
−0.0419	−0.3265	3.3885	0.3764	−0.2429	3.3885
0.0489	−0.3534	3.3885	0.2870	−0.2231	3.3885
0.1403	−0.3772	3.3885	0.1979	−0.2019	3.3885
0.2324	−0.3975	3.3885	0.1094	−0.1791	3.3885
0.3252	−0.4143	3.3885	0.0214	−0.1542	3.3885
0.4186	−0.4277	3.3885	−0.0660	−0.1271	3.3885
0.5126	−0.4377	3.3885	−0.1526	−0.0977	3.3885
0.6072	−0.4446	3.3885	−0.2385	−0.0660	3.3885
0.7023	−0.4486	3.3885	−0.3237	−0.0320	3.3885
0.7945	−0.4499	3.3885	−0.4050	0.0030	3.3885
0.8835	−0.4489	3.3885	−0.4827	0.0387	3.3885
0.9694	−0.4460	3.3885	−0.5566	0.0748	3.3885
1.0519	−0.4414	3.3885	−0.6271	0.1113	3.3885
1.1312	−0.4354	3.3885	−0.6942	0.1478	3.3885
1.2073	−0.4284	3.3885	−0.7579	0.1840	3.3885
1.2800	−0.4206	3.3885	−0.8184	0.2198	3.3885
1.3495	−0.4121	3.3885	−0.8733	0.2534	3.3885
1.4125	−0.4038	3.3885	−0.9223	0.2843	3.3885
1.4692	−0.3957	3.3885	−0.9662	0.3124	3.3885
1.5197	−0.3883	3.3885	−1.0046	0.3374	3.3885
1.5668	−0.3812	3.3885	−1.0379	0.3591	3.3885
1.6078	−0.3751	3.3885	−1.0660	0.3775	3.3885
1.6392	−0.3702	3.3885	−1.0900	0.3933	3.3885
1.6643	−0.3664	3.3885	−1.1105	0.4061	3.3885
1.6832	−0.3633	3.3885	−1.1278	0.4159	3.3885
1.6970	−0.3598	3.3885	−1.1422	0.4227	3.3885
1.7023	−0.3540	3.3885	−1.1536	0.4270	3.3885
1.7039	−0.3491	3.3885	−1.1625	0.4292	3.3885
1.7041	−0.3465	3.3885	−1.1701	0.4297	3.3885
1.7040	−0.3453	3.3885	−1.1761	0.4285	3.3885
−1.1824	0.3664	3.6476	1.6953	−0.4151	3.6476
−1.1845	0.3621	3.6476	1.6953	−0.4145	3.6476
−1.1845	0.3555	3.6476	1.6949	−0.4133	3.6476
−1.1825	0.3478	3.6476	1.6941	−0.4110	3.6476
−1.1787	0.3390	3.6476	1.6914	−0.4068	3.6476
−1.1723	0.3278	3.6476	1.6849	−0.4026	3.6476
−1.1630	0.3141	3.6476	1.6713	−0.4027	3.6476
−1.1502	0.2980	3.6476	1.6531	−0.4047	3.6476
−1.1335	0.2791	3.6476	1.6287	−0.4072	3.6476
−1.1130	0.2573	3.6476	1.5983	−0.4102	3.6476
−1.0885	0.2323	3.6476	1.5586	−0.4135	3.6476
−1.0590	0.2033	3.6476	1.5129	−0.4167	3.6476
−1.0242	0.1708	3.6476	1.4640	−0.4193	3.6476
−0.9838	0.1350	3.6476	1.4091	−0.4215	3.6476
−0.9378	0.0959	3.6476	1.3481	−0.4229	3.6476
−0.8857	0.0541	3.6476	1.2808	−0.4233	3.6476
−0.8274	0.0101	3.6476	1.2105	−0.4226	3.6476
−0.7655	−0.0339	3.6476	1.1372	−0.4205	3.6476
−0.6999	−0.0776	3.6476	1.0609	−0.4170	3.6476
−0.6305	−0.1210	3.6476	0.9817	−0.4118	3.6476
−0.5570	−0.1635	3.6476	0.8997	−0.4048	3.6476
−0.4797	−0.2050	3.6476	0.8148	−0.3959	3.6476
−0.3981	−0.2456	3.6476	0.7272	−0.3849	3.6476
−0.3124	−0.2848	3.6476	0.6367	−0.3717	3.6476
−0.2250	−0.3211	3.6476	0.5464	−0.3565	3.6476
−0.1361	−0.3547	3.6476	0.4563	−0.3395	3.6476

TABLE 1-continued

SUCTION SIDE			PRESSURE SIDE		
X	Y	Z	X	Y	Z
−0.0459	−0.3854	3.6476	0.3665	−0.3211	3.6476
0.0450	−0.4129	3.6476	0.2772	−0.3011	3.6476
0.1363	−0.4373	3.6476	0.1883	−0.2796	3.6476
0.2281	−0.4584	3.6476	0.0997	−0.2563	3.6476
0.3206	−0.4761	3.6476	0.0119	−0.2310	3.6476
0.4137	−0.4902	3.6476	−0.0754	−0.2033	3.6476
0.5072	−0.5010	3.6476	−0.1621	−0.1734	3.6476
0.6013	−0.5087	3.6476	−0.2479	−0.1411	3.6476
0.6959	−0.5135	3.6476	−0.3329	−0.1065	3.6476
0.7876	−0.5156	3.6476	−0.4139	−0.0710	3.6476
0.8766	−0.5152	3.6476	−0.4914	−0.0348	3.6476
0.9622	−0.5128	3.6476	−0.5651	0.0020	3.6476
1.0445	−0.5088	3.6476	−0.6354	0.0390	3.6476
1.1238	−0.5034	3.6476	−0.7023	0.0762	3.6476
1.1997	−0.4967	3.6476	−0.7657	0.1131	3.6476
1.2724	−0.4893	3.6476	−0.8258	0.1497	3.6476
1.3417	−0.4813	3.6476	−0.8801	0.1841	3.6476
1.4046	−0.4733	3.6476	−0.9287	0.2159	3.6476
1.4613	−0.4655	3.6476	−0.9720	0.2449	3.6476
1.5116	−0.4583	3.6476	−1.0098	0.2708	3.6476
1.5587	−0.4513	3.6476	−1.0426	0.2934	3.6476
1.5995	−0.4452	3.6476	−1.0702	0.3127	3.6476
1.6309	−0.4404	3.6476	−1.0938	0.3291	3.6476
1.6561	−0.4365	3.6476	−1.1138	0.3426	3.6476
1.6748	−0.4336	3.6476	−1.1308	0.3530	3.6476
1.6885	−0.4300	3.6476	−1.1450	0.3605	3.6476
1.6937	−0.4242	3.6476	−1.1561	0.3655	3.6476
1.6953	−0.4195	3.6476	−1.1648	0.3683	3.6476
1.6954	−0.4170	3.6476	−1.1724	0.3693	3.6476
1.6954	−0.4156	3.6476	−1.1785	0.3687	3.6476

It will also be appreciated that the airfoil **200** disclosed in the above scalable Table 1 may be non-scaled, scaled up or scaled down geometrically for use in other similar turbine/compressor designs. Consequently, the coordinate values set forth in Table 1 may be non-scaled, scaled upwardly or scaled downwardly such that the general airfoil profile shape remains unchanged. A scaled version of the coordinates in Table 1 would be represented by X, Y and Z coordinate values of Table 1, with the X, Y and Z non-dimensional coordinate values converted to inches or mm (or any suitable dimensional system), multiplied or divided by a constant number. The constant number may be a fraction, decimal fraction, integer or mixed number.

The article of manufacture may also have a suction-side nominal profile substantially in accordance with suction-side Cartesian coordinate values of X, Y and Z set forth in scalable Table 1. The Cartesian coordinate values of X, Y and Z are non-dimensional values convertible to dimensional distances by multiplying the Cartesian coordinate values of X, Y and Z by a number. The X and Y coordinates, when connected by smooth continuing arcs, define airfoil profile sections at each Z height. The airfoil profile sections at each Z height are joined smoothly with one another to form a complete suction-side airfoil shape. The X, Y and Z coordinate values being scalable as a function of a number to provide a non-scaled, scaled-up or scaled-down airfoil profile.

The article of manufacture may also have a pressure-side nominal airfoil profile substantially in accordance with pressure-side Cartesian coordinate values of X, Y and Z set forth in scalable Table 1. The Cartesian coordinate values of X, Y and Z are non-dimensional values convertible to dimensional distances by multiplying the Cartesian coordinate values of X, Y and Z by a number, X and Y are coordinates which, when connected by smooth continuing arcs, define airfoil profile sections at each Z height. The airfoil profile sections at each Z height are joined smoothly with one another to form a complete pressure-side airfoil shape. The X, Y and Z values being scalable as a function of the number to provide at least one of a non-scaled, scaled-up and scaled-down airfoil.

The article of manufacture may be an airfoil or an exit guide vane configured for use with a compressor. The suction-side airfoil shape may lie in an envelope within +/−5% of a chord length in a direction normal to a suction-side airfoil surface location, or +/−0.25 inches in a direction normal to a suction-side airfoil surface location.

The number, used to convert the non-dimensional values to dimensional distances, may be a fraction, decimal fraction, integer or mixed number. The height of the article of manufacture may be about 1 inch to about 15 inches or more, or any suitable height as desired in the specific application.

A compressor **2**, according to an aspect of the present invention, may include a plurality of exit guide vanes **27**. Each of the exit guide vanes **27** include an airfoil **200** having a suction-side **310** airfoil shape, the airfoil **200** having a nominal profile substantially in accordance with suction-side **310** Cartesian coordinate values of X, Y and Z set forth in scalable Table 1. The Cartesian coordinate values of X, Y and Z are non-dimensional values convertible to dimensional distances by multiplying the Cartesian coordinate values of X, Y and Z by a number. The number, used to convert the non-dimensional values to dimensional distances, may be a fraction, decimal fraction, integer or mixed number. X and Y are coordinates which, when connected by smooth continuing arcs, define airfoil profile sections at each Z height. The airfoil profile sections at each Z height being joined smoothly with one another to form a complete suction-side **310** airfoil shape.

The compressor **2**, according to an aspect of the present invention, may also have a plurality of exit guide vanes **27** having a pressure-side **320** nominal airfoil profile substantially in accordance with pressure-side Cartesian coordinate values of X, Y and Z set forth in scalable Table 1. The Cartesian coordinate values of X, Y and Z are non-dimensional values convertible to dimensional distances by multiplying the Cartesian coordinate values of X, Y and Z by a number. The number (which would be the same number used for the suction side) may be a fraction, decimal fraction, integer or mixed number. X and Y are coordinates which, when connected by smooth continuing arcs, define airfoil profile sections at each Z height, the airfoil profile sections at each Z height being joined smoothly with one another to form a complete pressure-side airfoil shape.

An important term in this disclosure is profile. The profile is the range of the variation between measured points on an airfoil surface and the ideal position listed in scalable Table 1. The actual profile on a manufactured blade may be different than those in scalable Table 1 and the design is robust to this variation meaning that mechanical and aerodynamic function are not impaired. As noted above, an approximately + or −5% chord and/or 0.25 inch profile tolerance is used herein. The X, Y and Z values are all non-dimensionalized.

The following are non-limiting examples of the airfoil profiles embodied by the present invention. On some compressors, each airfoil profile section (e.g., at each Z height) may be connected by substantially smooth continuing arcs. On other compressors, some of the airfoil profile sections may be connected by substantially smooth continuing arcs. Embodiments of the present invention may also be employed by a compressor having stage(s) with no airfoil profile sections connected by substantially smooth continuing arcs.

The disclosed airfoil shape increases reliability and is specific to the machine conditions and specifications. The airfoil shape provides a unique profile to achieve (1) interaction between other stages in the compressor; (2) aerodynamic efficiency; and (3) normalized aerodynamic and mechanical blade or vane loadings. The disclosed loci of points allow the gas turbine and compressor or any other suitable turbine/compressor to run in an efficient, safe and smooth manner. As also noted, any scale of the disclosed airfoil may be adopted as long as (1) interaction between other stages in the compressor; (2) aerodynamic efficiency; and (3) normalized aerodynamic and mechanical blade loadings are maintained in the scaled compressor.

The airfoil **200** described herein thus improves overall compressor **2** efficiency. Specifically, the airfoil **200** provides the desired turbine/compressor efficiency lapse rate (ISO, hot, cold, part load, etc.). The airfoil **200** also meets all aeromechanics, loading and stress requirements.

It should be understood that the finished article of manufacture, blade or vane does not necessarily include all the sections defined in the one or more tables listed above. The portion of the airfoil proximal to a platform (or dovetail) and/or tip may not be defined by an airfoil profile section. It should be considered that the airfoil proximal to the platform or tip may vary due to several imposed constraints. The airfoil contains a main profile section that is substantially defined between the inner and outer flowpath walls. The remaining sections of the airfoil may be partly, at least partly or completely located outside of the flowpath. At least some of these remaining sections may be employed to improve the curve fitting of the airfoil at its radially inner or outer portions. The skilled reader will appreciate that a suitable fillet radius may be applied between the platform and the airfoil portion of the article of manufacture, blade or vane.

This written description uses examples to disclose the invention, including the best mode, and also to enable any person skilled in the art to practice the invention, including making and using any devices or systems and performing any incorporated methods. The patentable scope of the invention is defined by the claims, and may include other examples that occur to those skilled in the art. Such other examples are intended to be within the scope of the claims if they have structural elements that do not differ from the literal language of the claims, or if they include equivalent structural elements with insubstantial differences from the literal languages of the claims.

The invention claimed is:

1. An article of manufacture having a nominal airfoil profile substantially in accordance with Cartesian coordinate values of X, Y and Z set forth in scalable Table 1 wherein the Cartesian coordinate values of X, Y and Z are non-dimensional values convertible to dimensional distances by multiplying the Cartesian coordinate values of X, Y and Z by a number, and wherein X and Y are coordinates which, when connected by continuing arcs, define airfoil profile sections at each Z height, the airfoil profile sections at each Z height being joined smoothly with one another to form a complete airfoil shape.

2. The article of manufacture according to claim **1**, wherein the article of manufacture comprises an exit guide vane configured for use with a compressor.

3. The article of manufacture according to claim **1**, wherein the airfoil shape lies in an envelope within:

+/−5% of a chord length in a direction normal to an airfoil surface location.

4. The article of manufacture according to claim **1**, wherein the number, used to convert the non-dimensional values to dimensional distances, is at least one of a fraction, decimal fraction, integer and mixed number.

5. The article of manufacture according to claim **1**, wherein a height of the article of manufacture is about 1 inch to about 15 inches.

6. An article of manufacture having a suction-side nominal airfoil profile substantially in accordance with suction-side Cartesian coordinate values of X, Y and Z set forth in scalable Table 1 wherein the Cartesian coordinate values of X, Y and Z are non-dimensional values convertible to dimensional distances by multiplying the Cartesian coordinate values of X, Y and Z by a number, and wherein X and Y are coordinates which, when connected by continuing arcs, define airfoil profile sections at each Z height, the airfoil profile sections at each Z height being joined smoothly with one another to form a complete suction-side airfoil shape, the X, Y and Z coordinate values being scalable as a function of the number to provide at least one of a non-scaled, scaled-up and scaled-down airfoil profile.

7. The article of manufacture according to claim **6** wherein the article of manufacture comprises an exit guide vane configured for use with a compressor.

8. The article of manufacture according to claim **6**, wherein the suction-side airfoil shape lies in an envelope within:

+/−5% of a chord length in a direction normal to a suction-side airfoil surface location.

9. The article of manufacture according to claim **6**, wherein the number, used to convert the non-dimensional values to dimensional distances, is at least one of a fraction, decimal fraction, integer and mixed number.

10. The article of manufacture according to claim **6**, wherein a height of the article of manufacture is about 1 inch to about 15 inches.

11. The article of manufacture according to claim **6**, further comprising the article of manufacture having a pressure-side nominal airfoil profile substantially in accordance with pressure-side Cartesian coordinate values of X, Y and Z set forth in scalable Table 1 wherein the Cartesian coordinate values of X, Y and Z are non-dimensional values convertible to dimensional distances by multiplying the Cartesian coordinate values of X, Y and Z by the number, and wherein X and Y are coordinates which, when connected by continuing arcs, define airfoil profile sections at each Z height, the airfoil profile sections at each Z height being joined smoothly with one another to form a complete pressure-side airfoil shape, the X, Y and Z values being scalable as a function of the number to provide at least one of a non-scaled, scaled-up and scaled-down airfoil.

12. A compressor comprising a plurality of exit guide vanes, each of the exit guide vanes including an airfoil having a suction-side airfoil shape, the airfoil having a nominal profile substantially in accordance with suction-side Cartesian coordinate values of X, Y and Z set forth in scalable Table **1** wherein the Cartesian coordinate values of X, Y and Z are non-dimensional values convertible to dimensional distances by multiplying the Cartesian coordinate values of X, Y and Z by a number, and wherein X and Y are coordinates which, when connected by continuing arcs, define airfoil profile sections at each Z height, the airfoil profile sections at each Z height being joined smoothly with one another to form a complete suction-side airfoil shape.

13. The compressor according to claim **12**, wherein the suction-side airfoil shape lies in an envelope within:

+/−5% of a chord length in a direction normal to a suction-side airfoil surface location.

14. The compressor according to claim **12**, wherein the number, used to convert the non-dimensional values to dimensional distances, is at least one of a fraction, decimal fraction, integer and mixed number.

15. The compressor according to claim **12**, wherein a height of each exit guide vane is about 1 inch to about 15 inches.

16. The compressor according to claim **12**, further comprising each of the plurality of exit guide vanes having a pressure-side nominal airfoil profile substantially in accordance with pressure-side Cartesian coordinate values of X, Y and Z set forth in scalable Table 1 wherein the Cartesian coordinate values of X, Y and Z are non-dimensional values convertible to dimensional distances by multiplying the Cartesian coordinate values of X, Y and Z by the number, and wherein X and Y are coordinates which, when connected by continuing arcs, define airfoil profile sections at each Z height, the airfoil profile sections at each Z height being joined smoothly with one another to form a complete pressure-side airfoil shape.

17. The compressor according to claim **16**, wherein the pressure-side airfoil shape lies in an envelope within:

+/−5% of a chord length in a direction normal to a pressure-side airfoil surface location.

18. The compressor according to claim **16**, wherein the number, used to convert the non-dimensional values to dimensional distances, is at least one of a fraction, decimal fraction, integer and mixed number.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 8,961,119 B2
APPLICATION NO. : 13/526941
DATED : February 24, 2015
INVENTOR(S) : McKeever et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Specification

In Column 2, Line 25, delete “an” and insert -- any --, therefor.

In Column 2, Line 52, delete “drawings.” and insert -- drawings, --, therefor.

In Column 3, Line 4, delete “reference” and insert -- reference), --, therefor.

In Column 3, Line 15, delete “or inlet)” and insert -- (or inlet) --, therefor.

In Column 4, Line 57, delete “for” and insert -- four --, therefor.

In Column 16, Line 46, delete “nominal” and insert -- nominal airfoil --, therefor.

In Column 16, Line 64, delete “number,” and insert -- number. --, therefor.

Signed and Sealed this
First Day of December, 2015

Michelle K. Lee
Director of the United States Patent and Trademark Office